NISTIR 4868

Interim Report: Preliminary Sitewide Survey of Reinforced Concrete Structural Deterioration at NIST

Lawrence I. Knab
Research Civil Engineer

U.S. DEPARTMENT OF COMMERCE
Technology Administration
National Institute of Standards
and Technology
Building Materials Division
Building and Fire Research Laboratory
Gaithersburg, MD 20899

NIST

NISTIR 4868

Interim Report: Preliminary Sitewide Survey of Reinforced Concrete Structural Deterioration at NIST

Lawrence I. Knab
Research Civil Engineer

U.S. DEPARTMENT OF COMMERCE
Technology Administration
National Institute of Standards
and Technology
Building Materials Division
Building and Fire Research Laboratory
Gaithersburg, MD 20899

August 1992

U.S. DEPARTMENT OF COMMERCE
Barbara Hackman Franklin, Secretary

TECHNOLOGY ADMINISTRATION
Robert M. White, Under Secretary for Technology

NATIONAL INSTITUTE OF STANDARDS
AND TECHNOLOGY
John W. Lyons, Director

Interim Report: Preliminary Sitewide Survey of Reinforced Concrete Structural Deterioration at NIST

by

Lawrence I. Knab[1]

August, 1992

---

[1] Research Civil Engineer, Building Materials Division, NIST

ABSTRACT

A sitewide investigation of the condition of the reinforced concrete is being carried out at the NIST facilities in Gaithersburg, MD. In the first phase, a visual survey was conducted primarily in the interior of buildings and their adjacent structures. Additionally, over 40 percent (78 out of 175) of the electric, signal, and telephone manholes were visually surveyed and their walls and ceilings were sounded for delamination. This interim report presents the observed distress, presents a priority list for repairing the deteriorated concrete areas, identifies needed tests, and shows the anticipated locations and costs of test samples.

KEYWORDS: carbonation, chloride ion, concrete, condition, corrosion, cost, deterioration, repair, reinforcement, testing

ACKNOWLEDGEMENTS

The author would like to acknowledge the invaluable input of Ms. Myrna L. Mills, Structural Engineer, previously with the Plant Division and now with U. S. Department of State, Foreign Buildings Operations, and Richard Mackenzie, Planner/ Estimator of the Plant Division. Their assistance and support both in conducting the survey and in establishing the priority rankings are gratefully acknowledged. Jan Dysart of the Plant Division is acknowledged for her assistance in preparing the drawings. Special thanks are given to the Electric Shop, including Don Bruchey (foreman), Jim Mace (leader), Gary Moon, Lloyd Beddow, Chris Best, and Richard Rhodabeck, for their cooperation in assisting in surveying the electric, signal, and telephone manholes. The assistance from the Fire Department for testing the air quality and safety of the manholes is also appreciated. The author is indebted to Chris Conley, Jim Gross, Geoff Frohnsdorff, Jim Clifton, and Bob Mathey for their constructive suggestions and guidance. Finally, Nick Carino of the Structures Division is acknowledged for his helpful review comments.

Table of Contents

1. INTRODUCTION

The condition of the reinforced concrete under the Red Auditorium and in the steam manholes at NIST has created an increased awareness of the concrete deterioration at NIST. As a result, in February 1991, the Plant Division and the Inorganic Materials Group of the Building Materials Division began a sitewide survey of deterioration of reinforced concrete structures on the NIST campus in Gaithersburg MD. The purpose of the investigation is to identify potential problem areas, to provide a rough indication of remaining service life, to establish a priority list for repairing the deteriorated concrete areas, and to provide cost estimates for design and construction repairs.

During the first phase, visual observations and soundings of selected structures were used to identify potential problem areas and future testing locations. This interim report is intended to be used and updated by the Plant Division for planning and decision-making for FY 92 and beyond. For the buildings and manholes investigated, it presents the observed distress, identifies the needed tests, shows the anticipated locations and costs of test samples, and presents an initial evaluation and priority list for repairing the deteriorated concrete structures.

After the tests identifed in the first phase are conducted, a final report will be prepared documenting the results of the visual survey and the non-destructive and destructive concrete testing performed on the reinforced concrete facilities at NIST. The final report will include interpretation of test results, identification of damaged areas, rough estimates of the remaining service life, assignment of priority with respect to repair, identification of areas requiring further tests or evaluation to determine the state of deterioration, and cost estimates for design and construction repairs.

2. SURVEY PERFORMED

The visual survey and sounding were conducted in the interior of buildings and their adjacent structures (e.g., air intake pits and material storage bins). Only the exposed reinforced concrete surfaces, that is, those not covered or obscured by cladding, tile, brick, ducts, etc., were observed. Some visible portions of exterior foundation walls of buildings and adjacent retaining walls were also observed. Additionally, in an effort to determine which manholes need replacement, over 40 percent (78 out of 175) of the electric, signal, and telephone manholes were visually surveyed and their four walls and ceilings were sounded for delamination. Mounted objects, particularly the asbestos-insulated, high-voltage lines in the electric manholes, prevented observation and sounding

on the wall areas behind the objects.

2.1 Methods

2.1.1 Visual Observations

Visual indications of distress noted included concrete cracking, rust stains, delaminations, exposed reinforcing steel, spalling, evidence of water movement or leakage, honeycombing, and efflorescence.

2.1.2 Sounding with Hammer

A hand-held carpenter's hammer was used to lightly tap and, by listening, identify delaminated areas which sounded hollow. Because there is a high likelihood that delaminated areas are the result of corrosion of the reinforcing steel, these areas were given a high priority for repair.

2.2 Results and Evaluation

2.2.1 Observed Distress for Buildings and Related Structures

The "Remarks" section in Table 1 include observed signs of distress, such as delamination based on sounding or cracking and conditions associated with the distress, such as water leakage. "Delamination" and "efflorescence" as used in Table 1 are defined as [1]: (i) delamination is a splitting, cracking, or separation of a concrete element (e.g., wall, ceiling, floor slab) in a plane roughly parallel to, and generally near the surface, of the element; and, (ii) efflorescence is a deposit of salts, usually white, formed on a concrete surface with the substance emerging from the concrete in solution and being deposited by evaporation.

The general locations of the cited areas of distress in Table 1 can be found in Figures 1 to 47, which show plan views for almost all of the buildings surveyed. Examples of distress are shown in Figures 48 to 76.

2.2.2 Observed Distress for Electric, Signal, and Telephone Manholes

To determine which manholes need replacement and to estimate their overall condition, 78 of 175 electric, signal, and telephone manholes were surveyed. (The remaining manholes need to be surveyed to determine which of them need replacement - see Section 3.5). The locations of almost all 175 manholes are shown in Figure 77 on a NIST sitewide map; the manholes surveyed are also shown in Figure 77. Figures 78 and 79 show the configuration of the manholes; each manhole number has one of the configurations shown in the figures and corresponds to one, two, three, or four individual manholes; when two or more individual manholes are in a configuration, they are connected as shown in Figures 78 and 79 as a single structure. As an example, manhole #15 has three individual manholes connected together: 15EL (electric), 15SG (signal), and 15TE (telephone).

The results of the survey of delamination and distress of 78 electric, signal, and telephone underground manholes are given in Table 2 (Tables 2a and 2b in metric and english units, respectively). For each of the 6 elements (four walls, ceiling, and access hole) within each manhole, the table provides the percent delamination, the total area, and the total delaminated area of each element. Also included are:

(i) summation of the percent delamination for the four walls, ceiling and the access hole, SUM %, with a maximum possible value of 600%, i.e., 100% delamination in all six of the elements, and (ii) the summation of the area of delamination for the six elements, SUM SM (metric).

Examples of observed distress are shown in Figures 80 to 99.

2.2.3 Ranking of Electric, Signal, and Telephone Manholes

Rankings of the level of distress for the electric, signal, and telephone manholes are given in Table 3 (Tables 3a and 3b in metric and english units, respectively). The rankings are according to manhole number (2 or 3 manholes per number) and are based on the initial sitewide results given in Table 2. Three criteria were used in the ranking: (i) the summation of the percent delamination for the four walls, ceiling and the access hole (Sum %), (ii) the summation of the area of delamination for the six elements (Sum SM), and (iii) any other observations with regard to structural distress (discussed below).

A discussion follows of the relative weighting of the three criteria (stated above) used to determine the rankings given in Table 3.

In addition to areas that were clearly delaminated, there were areas that sounded as though they were likely delaminated, and were referred to as "ad" in the table. To account for the uncertainties, these "ad" areas were assigned 1/2 of their observed areas.

The ranking was expressed in terms of manhole numbers (Table 3), where each number had 2 or 3 manholes, because according to the site plans, each number was a single structure, with one or more elements of each manhole connected to an adjoining manhole. Most likely, each manhole grouping had similar materials and construction practices; all the manholes inspected appeared to be cast-in-place.

Another consideration is the difference in size between the electric and the signal and telephone manholes. The primary differences are the larger dimensions and corresponding surface areas of the electric compared with the signal and telephone manholes. A typical electric manhole measures 2.4 m (8 ft) deep (vertical) by 2.4 m by 3.7 m (8 ft by 12 ft) in its lateral (horizontal) dimensions. In contrast, the signal and telephone manholes typically measure 2.1 m (7 ft) deep by 1.2 m by 2.4 m (4 ft by 8 ft). The access hole for all types of manholes was about 0.9 m (3 ft) in each of the access hole's three dimensions. When comparing the ceilings, the ratio of the electric to signal manhole surface area is 3.8. When comparing the walls, the ratio of the electric to signal surface area varies from 3.4 to 1.1.

The electric manholes were considered to be more critical than the signal and telephone manholes for the following reasons. Because of the larger surface areas of the electric manholes, the bending, shear, and axial loads exerted on the walls and ceiling will be greater than for the signal and telephone manholes. And, for the same wall and ceiling thickness and amount of reinforcement, the ratio of applied load to strength (for a wall or ceiling) would be greater for the electric manholes compared with the signal and telephone manholes. Based on limited information from the plans, the thickness of all walls and ceilings of all manholes is thought to be 200 mm (8 in.) (Actual thickness measurements should be verified for several manholes). Also, based on limited information from the plans, the reinforcement bar size (13 mm (#4)) in the electric, signal, and telephone manholes is thought to be the same but the bar spacing in the electric manholes is thought to be closer (230 vs. 300 mm (9 vs. 12 in.) on centers) than in the signal and telephone manholes. (Actual bar size, location, spacing (distance between bars), and cover should be verified for several manholes). Although a structural analysis would be required to determine the exact increase in structural strength due to the closer bar spacing, this difference in bar spacing was not considered sufficient to offset the large difference in surface area of the electric as compared to the signal and telephone manholes. Thus, the walls and ceilings of the electric manholes

were judged to be more critical than those of the signal and telephone manholes. For the same percentage of delamination, the total surface area of delamination will be greater for electric as compared with signal and telephone manholes. Thus, although both the Sum % and Sum SM values were used in ranking the manhole groupings, the Sum SM value, which reflects the larger surface area of the electric manholes, was given more importance than the Sum %.

In addition to using the Sum % and Sum SM values, any potentially-serious visual signs of structural distress (e.g., severe delamination, spalling, cracking, or collapsed blockout) or other circumstances (e.g., truck loading) were also taken into consideration when ranking the manholes.

2.2.4 Combined Ranking of Buildings and Electric, Signal, and Telephone Manholes

The more important distress areas for all structures investigated (buildings and related structures, electric, signal, telephone manholes) are shown in Table 4 along with information on whether or not there are safety or structural concerns or both. Some of these distressed areas are shown in Figures 48 to 76 and 80 to 99. Safety concerns included the potential for delaminated concrete falling from overhead or tripping on stairs. Information given on addressing the potential for hazardous falling concrete due to delaminated concrete is given in Appendix A. Concerns include both structural safety (e.g., Buildings 233 (Rm. A121), 245 (Rm. A 120), 231 (Rm. A169 "Sump"), and 206 (westernmost bins) and a number of the manholes) and integrity (i.e., deterioration of element which is not critical from a structural point of view, such as a loading dock wall, or stairs).

Included in Table 4, are action priority rankings, with the distressed areas ranked as high (H), medium (M), or low (L). A high ranking indicates that the area is in urgent need of repair. A medium ranking means that the area should be repaired after the high ranking areas are repaired. Finally, a low ranking indicates that the area needs (i) to repaired after the high and medium rank repairs are made, or (ii) to be kept under surveillance and, if necessary, repaired. With all the rankings, specified testing or additional evaluation may change the assigned ranking. Under the high rank (H), H-1 is the most important of high rank, H-2 is next most important, etc.; M-1 is the most important of medium rank, M-2 is next most important, etc.; and L-1 is the most important of low rank, L-2 is next most important, etc. Under this ranking scheme, the least important high ranking item (H-5) would be in more urgent need of repair than the most important medium ranking item (M-1).

If it is found that delaminated concrete is in danger of falling or being dislodged then the hazard for falling delaminated concrete

exists and should be addressed as soon as possible. (Some of the delaminated concrete has been removed as shown in Table 1). It is noted that any removal of delaminated concrete must be done without significantly weakening the structure. When removing delaminated concrete, a structural engineer's guidance should be sought to assure that the removal does not compromise the structural safety. A proposed approach for removal of delaminated concrete is given in Appendix A, Section A2.

The rankings in Table 4 are based on engineering judgment and therefore should be taken as initial input. Further details of the criteria used for the rankings are given in Table 4.

3. PROPOSED FURTHER TESTING AND EVALUATION

During the initial visual survey, locations were identified for measuring the chloride content and carbonation depth. Where distressed areas were observed, locations for both chloride and carbonation depth samples were usually identified. Test locations were also identified in areas not having visible distress in order to estimate the future potential for deterioration.

The rationale for choosing the chloride content and carbonation depth, along with a brief description of the test methods that will be used to measure them, are presented in Sections 3.1.1 and 3.1.2.

Limited examinations for alkali-aggregate, sulfate, and freeze-thaw attack are also proposed and are described in Sections 3.1.3 and 3.1.4.

3.1 Test Methods

3.1.1 Chloride Content

When chloride is present in concrete above a certain amount, termed the "chloride corrosion threshold," corrosion may occur, if other necessary conditions are satisfied, mainly the presence of moisture and oxygen [2]. Chloride contents in excess of the generally accepted critical content required to induce rebar corrosion were found in the corrosion-deteriorated reinforced concrete in the Red Auditorium and the steam manholes. It is likely that calcium chloride was added to concrete placed at NIST in cold weather to accelerate its hardening. To determine if the other NIST reinforced concrete structures have excessive chlorides, it is proposed that the total acid-soluble chloride content of hardened concrete samples taken from the other NIST structures be determined according to ASTM C 114 [3]. It is also proposed that the

technique for obtaining a sample of hardened concrete given by AASHTO T 260 [4] be used. The chloride content will be reported as the total mass of acid-soluble chloride per unit mass of concrete (cement, water, aggregate, and admixtures). From the reported chloride content, the percent chloride by mass of cement can be estimated by assuming a cement content.

If available, information on those structures for which the concrete was poured in cold weather should be used to identify structures which probably contain concrete with excessive amounts of chloride.

It is proposed that powdered samples for chloride analyses be taken at the approximate depth of the reinforcing steel. In addition, a small piece of concrete is to be taken from each 51 mm (2 in.) diameter core taken (see Section 3.1.2) to determine the chloride content. The proper sampling depth (see above) should be used. With through-thickness cores, two samples are to be taken, with each sample being taken at the proper sampling depth from each of the ends. The samples from the core will be ground into a powder prior to determining the chloride content (see AASHTO T 260 [4]).

3.1.2 Carbonation Depth

Corrosion can also occur due to carbonation of the concrete, caused by carbon dioxide from the air or dissolved in water reacting with the calcium hydroxide in the concrete, reducing the pH to about 8.5 at which level the steel is no longer passive and corrosion may occur [2]. Parrott [5] states that in carbonated concrete, corrosion initiates at a pH of about 11, but that the presence of chlorides can raise this pH threshold. Carbonation is most rapid in porous concrete. Some of the concrete samples from the Red Auditorium and the steam manholes showed substantial carbonation depths. In a number of cases, the depths were nearly as deep or deeper than the concrete cover of the reinforcing steel. Based on the carbonation depths, it is believed that carbonation may be acting together with the chlorides to accelerate corrosion. Therefore, it is proposed that a limited number of 51 mm (2 in.) diameter cores be sampled for carbonation depth according to RILEM Recommendation CPC-18 [6]. As proposed above, each core measured for carbonation depth will also be measured for chloride content, to determine whether one or both of these effects are conducive to corrosion.

In certain cases, for example, where the core extends through a wall, a chloride sample and carbonation depth will be taken from both sides of the wall.

Care should be taken not to damage reinforcing steel bars when taking cores. A cover meter can be used as an aid to locate steel

bars.

3.1.3 Alkali Aggregate and Sulfate Attack

Based on the visual survey, it is proposed that a limited number of concrete cores (76 mm (3 in.) minimum diameter) be examined for alkali-aggregate reaction, from at least one electric, signal or telephone manhole and one loading dock. In these reactions, alkali hydroxides in the concrete react with certain minerals in the aggregates, in the presence of moisture, to form expansive products. If the preliminary petrographic examination using ASTM C 856 [7] show indications of alkali-aggregate expansion and the aggregate is siliceous, additional accelerated testing can be performed according to ASTM P214 [8]. Determination of alkali-carbonate reaction will be determined according to ASTM C 856 [7].

When the core or cores from the manholes are used for determining alkali-aggregate reaction they will also be examined for sulfate attack, as well as chloride content and carbonation depth.

3.1.4 Freezing and Thawing

Several exterior areas with severe distress which may be caused by freezing and thawing were identified in the visual survey.

A brief discussion is given on some factors to be considered in repairing exterior concrete exposed to water. Prior to repairing exterior deteriorated concrete, it should be determined if the deterioration is due to freeze-thaw damage. A sample of the concrete should be taken to determine if it has entrained air bubbles, and if entrained air is present, the concrete should be tested according to ASTM C 457 [9] to determine if it has adequate entrained air. If the deterioration is being caused by freezing and thawing, repairs to exterior, non-frost-resistant concrete substrates which may become critically saturated will most likely result in the repair failing because the substrate can fail by freeze-thaw attack. Therefore, for those structures which appear to have freeze-thaw damage it needs to be determined if air entrainment is present and adequate. If it is not adequate and the structure is exposed to freezing and thawing and sufficient water to cause saturation, it is not recommended that the structure be repaired. Rather, the concrete should be replaced with properly air-entrained concrete.

Even if it is demonstrated that the base concrete is freeze-thaw resistant, caution needs to be exercised in selecting a repair material that will perform satisfactorily. The effect of various

factors on the performance of the repair, such as shrinkage, thermal compatibility, temperature cycling, and moisture, including moisture buildup at or near the interface of the repair and its substrate, need to be considered [10]. Consideration should be given to using an air-entrained portland cement concrete repair material with properties similar to those of the base concrete.

3.2 Location of Test Samples

3.2.1 Buildings and Related Structures

The location and structural element for each chloride powder (P) and core (C) test sample are given in Table 1 for building and building-related structures. Under "Location," the room and the structural element, such as a beam, column, or ceiling slab from which the sample is to be taken is provided.

Almost all test locations in Table 1 have been identified by placing duct tape on or near the test location. The locations of almost all chloride-powder and carbonation-depth core samples are given in Figures 1 to 47. The total number of chloride powder and core samples and their location (either inside or outside of a building) for each building are given in Table 5.

Also, at least one core from a distressed region on a loading dock (e.g., southwest loading dock of Bldg. 245, see Core "C8", Table 1) should be used for carbonation depth and chloride content determinations and also examined for the existence and adequacy of an entrained air system (see Section 3.1.4) and alkali-aggregate reactivity (Section 3.1.3). The core(s) should be taken from a loading dock region which shows signs of distress that could possibly resemble freeze-thaw damage or alkali-aggregate expansive reaction or both. Map or pattern cracking is typical of alkali-aggregate deterioration. The diameter of the core used to determine the adequacy of the entrained air system should provide sufficient sampling area to comply with the requirements of ASTM C457 [9]. Determination of alkali-aggregate deterioration from one core (minimum diameter of 76 mm (3 in.)) only is proposed. If alkali-aggregate reaction is confirmed, additional cores should be taken from other suspected areas. Determination of the adequacy of air entrainment may require that cores be taken from more than one loading dock location.

3.2.2 Electric, Signal, and Telephone Manholes

Included in Table 2 are locations of 30 chloride content powder samples, designated by "P" followed by the manhole number and a

"E", "T", or "S" (for electric, signal, or telephone) and ending in "MH". Both the manhole number and manhole element (a wall, ceiling, or access hole) are designated for each sample. An example of a designation for a chloride powder sample from electric manhole No.5B EL would be "P5BEMH", and if it is to be taken from the south wall, its designation would appear under "S" (south wall; see Table 2). A similar designation scheme was used for the 9 cores selected, with the designation beginning with a "C".

With regard to selection, usually one chloride content sample was designated for each manhole number, where each number had a specific configuration (Figures 78 and 79), typically either two or three manholes. Each configuration is shown as a single structure, with one or more elements of each manhole connected to an adjoining manhole. It is most likely that there was more than one concrete pour for each manhole configuration. To get an indication of the quality of concrete, samples were selected from a given manhole number from either the ceiling or the walls. In some cases, preference was given to sampling from the signal and telephone manholes, as opposed to the electric manholes because of the asbestos insulation on the high voltage lines in the electric manholes. In contrast to the building samples, no duct tape was used to mark the locations in the manholes.

It is proposed that one core (minimum diameter of 76 mm (3 in.)) be taken to determine if alkali-aggregate or sulfate reaction is occurring. If the core shows alkali-aggregate or sulfate reaction, additional cores should be taken at other suspected locations. The core, which can also be used for carbonation depth and chloride depth (see Table 2), should be taken from manhole regions which show signs of distress that could possibly resemble alkali-aggregate expansion or sulfate deterioration or both. Map or pattern cracking is typical of these deterioration processes.

3.3 Conduct of Tests

It is recommended that a commercial materials testing agency conduct the sampling and testing specified in Tables 1 and 2. Appropriate safety measures need to be taken, including protection against the falling of delaminated concrete and the asbestos insulation in the electric manholes. The verification of asbestos was performed by the NIST Safety Office and was based on one sample from each of two manholes. In addition, some of the more severely deteriorated manholes (see Table 3) and other structures (e.g., westernmost material storage bins in Building 206) need to have their structural safety assessed prior to permitting personnel to enter. The Inorganic Materials Group (NIST) will conduct select materials tests, including alkali-aggregate and sulfate deterioration testing.

3.4 Cost Estimates for Testing

The estimated total cost of the tests is given in Table 5 for each building and for all electric, signal, and telephone manholes surveyed (cost is for all manholes taken together). The estimated testing cost for each priority ranking is given in Table 4.

3.5 Additional Structures to be Surveyed

In addition to the 78 electric, signal, and telephone manholes surveyed, about 97 more need to be surveyed. It is recommended that these 97 manholes be surveyed in a manner similar to the 78 manholes already surveyed. The total testing cost for the 97 manholes remaining is shown in Table 5 and was estimated based on the cost of the 78 manholes already surveyed (also see Recommendation No. 3, Section 4.2 resulting in a possible reduction in testing cost).

The results from the recommended investigations to be performed on the remaining 97 manholes would need to be related to the ranking of the 78 manholes already investigated.

Although not treated in detail in this report, structural investigations of 17 steam manholes have been previously performed [11]. Excessive chloride content and carbonation depths were found in the corrosion-deteriorated reinforced concrete in the steam manholes. It is recommended that structural investigations also be performed on the remaining 30 or so steam manholes not yet investigated. The investigations should be similar to those already done, except that data on compressive strength was found to be of little value and should not be collected. In addition, the usefulness of half-cell potential data should also be examined. As an example, where it is found by visual examination or sounding that a structural element is severely deteriorated, half-cell data would be of little value. If, however, based on visual inspection and sounding, the element is not severely deteriorated, the half-cell data could provide useful information on the corrosion activity of the reinforcing steel. It is recommended that visual and delamination surveys be carried out and that chloride ion contents and carbonation depths be measured, because these data were useful in ranking the order of replacement of the 17 manholes. The cost of performing 6 chloride ion contents (one for each of 4 walls and floor and ceiling) and 2 carbonation depths (3 carbonation depths were taken in previous investigations) for the steam manholes remaining to be investigated is given in Table 5. In computing the cost, it was assumed that the 2 cores for the carbonation depth would also be used for chloride ion content, requiring an additional 4 chloride ion powder samples, for a total

of 6 chloride ion contents per manhole. In the case of severely deteriorated manholes (e.g., those manholes which need to be replaced due to extensive delamination), it is not necessary to test for chloride content and carbonation depth.

If available, information on those steam manholes for which the concrete was poured in cold weather should be used to identify manholes which probably contain concrete with excessive amounts of chloride.

The results from the recommended structural investigations to be performed on the remaining 30 or so steam manholes would need to be related to the ranking of the 17 steam manholes already investigated [11].

The replacement schedule calls for one to four steam manholes to be replaced (#2F first, #19 second, #10A third, and #5 fourth) during FY 92, depending on funding. If funds are not available to replace all four manholes in FY92, then any manhole not replaced but having temporary shoring should be periodically reinspected to verify the structural safety of the manhole and its existing temporary shoring. In addition, any manholes not replaced and not having temporary shoring should be periodically reinspected to check their structural safety. Also, all manholes should be reinspected just prior to replacement to be sure they are safe to be occupied by workers during demolition operations.

The priority for replacing the steam manholes as well as performing additional structural investigations of the steam manholes is also shown in Table 4.

As was shown in Manhole # 67 (Tables 2 and 3), underground structures, such as electric, signal, telephone, and steam manholes which are subjected to vehicular traffic, including trucks, deserve additional attention. It is recommended that at least several structures be investigated which are subjected to truck traffic to determine the severity of the loading due to vehicular traffic. Decisions to repair or replace manholes should take into account loading due to vehicular traffic.

Sanitary, sewer, and water manholes, storm drains, and pits which are reinforced concrete should be investigated, at least to a limited degree, to see if problems exist. The sanitary manhole outside Gate E, in which weekly measurements of effluent are taken, should be included.

The tape tunnel, which is about 40 m (130 ft) long and located in the basement on the south side of Building 220, also needs to be investigated. The barracks and Pit #2 at the Nike Site also need to be investigated.

4. SUMMARY AND RECOMMENDATIONS

4.1 Summary

Preliminary results from the NIST sitewide investigation indicate a number of areas where substantial deterioration of the reinforced concrete is evident. In addition to the visual observation of buildings and their related structures, a detailed visual and delamination survey of 78 electric, signal, and telephone manholes was conducted. Testing will be necessary to determine the reasons for the deterioration. Hazards exist in some areas of deterioration, including the potential for falling delaminated concrete, exposure to asbestos (electric manholes), and damaged stairs which could cause tripping. In addition, with some structures there is a need to evaluate the potential for structural collapse (see Table 4).

Additional areas have been identified with some signs of deterioration, but which will require testing to provide a rough indication of their remaining service life.

Areas have also been selected for testing which do not have visible signs of distress. Often, these areas were chosen near moisture sources (e.g., moisture entry points or fill on the other side of a wall). Testing of these areas will provide information to provide a rough indication of their remaining service life.

4.2 Recommendations

1. The distressed areas identified in Table 4 need to be addressed as soon as possible. The rankings shown in the Table 4 are to be taken as initial input. According to the initial ranking (Table 4), distressed areas assigned a high priority (H) would be addressed first, in the order shown (H-1, H-2, etc.). The medium and low priority distressed areas would be addressed next (M-1, M-2, etc., L-1, L-2, etc). In cases of structural concern, the testing (Tables 1 and 2) should be completed along with one or more of the following: evaluation of the existing conditions (e.g., delamination survey), a structural analysis performed, a repair design prepared, and the actual repair performed. For example, Buildings 233 (Rm. A121), 245 (Rm. A 120), 231 (Rm. A169 "Sump"), and 206 (westernmost bins) are cases of structural concern. Some of the severely-deteriorated electric, signal, and telephone manholes may need to be replaced rather than repaired.

2. Cases where delaminated concrete is in danger of falling or being dislodged should be addressed as soon as possible, even if the ranking is not high.

Some of the delaminated concrete has already been removed (see Table 1). Areas which have had delaminated concrete removed should be periodically inspected for the reoccurrence of delaminated concrete. Special consideration should be given to areas which are frequented regularly or are subject to mechanical vibration; examples include Buildings 233 (Rm. A121), 245 (Rm. A120), and 231 (under the shored area).

It is noted that any removal of delaminated concrete must be done without significantly weakening the structure. When removing delaminated concrete, a structural engineer's guidance should be sought to assure that the removal does not compromise the structural safety. It is recommended that the proposed approach for removal of delaminated concrete be used as given in Appendix A, Section A2.

The stairs should be repaired or replaced where tripping is of concern.

3. Additional investigations of steam, electric, signal, and telephone manholes should be carried out as soon as possible and any distressed areas found should be addressed (see 1. above).

With regard to the electric, signal, and telephone manholes, two issues need to be addressed: which manholes need to be repaired or replaced, and what is the mechanism of deterioration.

- repair or replacement: the remaining 97 manholes should be surveyed to determine which ones need to be repaired or replaced, and

- mechanism of deterioration: to determine if corrosion is the prevalent mechanism of deterioration, a select set of chloride and carbonation depth determinations specified in Table 2 should be taken from several manholes with severe deterioration and several manholes with little deterioration. This select set of test data (chloride and carbonation) should then be used, along with one or several determinations for alkali- aggregate and sulfate degradation (see Section 3.2.2), to determine the causes of degradation. Depending on the determination of the causes of degradation, a decision should be made whether to conduct the remaining chloride and carbonation tests shown in Table 2 for the 78 manholes. For example, if chloride or carbonation is found to be the cause of deterioration, then it may be necessary to sample only those manholes which are not severely deteriorated.

If available, information on those manholes for which the concrete was poured in cold weather should be used to identify manholes which probably contain concrete with excessive amounts of chloride.

4. All testing as shown in Tables 1 and 2 should be conducted in the near future. Analysis of the testing will enable the determination of the causes of the deterioration in the reinforced concrete structures at NIST. Thus, the determination of repairs required in the near future and a rough indication of the remaining service life can be made.

5. Appropriate safety measures, including protection against the asbestos insulation in the electric manholes and the falling of delaminated concrete (see 2. above), need to be taken. Prior to disturbing fireproofing material on steel shapes (e.g., by sampling, removal of delaminated material, or repair), the fireproofing material should be checked to be sure it does not contain asbestos. As an example, Building 231 has fireproofing material on steel shapes. In Building 245, it needs to be verified if there is lead dust in the concrete in certain sampling locations (see Table 1). In Building 235, there is concrete that is to be inspected and sampled in a high radiation area; inspection and sampling cannot occur until it is demonstrated that it is safe to do so.

In addition, it is recommended that some structures, such as some manholes and the westernmost materials storage bins in Building 206, have their structural safety assessed prior to permitting personnel to enter them.

5. REFERENCES

1. "Cement and Concrete Terminology," ACI 116R-78, ACI Manual of Concrete Practice, 1991.

2. "Corrosion of Metals in Concrete," Report by Committee 222, ACI 222R-89, American Concrete Institute, 1989.

3. "Standard Methods for Chemical Analysis of Hydraulic Cement," ASTM C 114, Section 19 "Chloride (Reference Test Method)", ASTM Vol. 04.01.

4. "Standard Method of Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials," AASHTO Designation T 260.

5. Parrott, L. J., "Damage Caused by Carbonation of Reinforced Concrete," RILEM Materials and Structures, 1990, 23, 230-234.

6. RILEM Recommendation CPC-18, "Measurement of Hardened Concrete Carbonation Depth."

7. "Standard Practice for Petrographic Examination of Hardened Concrete," ASTM C856 - 83.

8. "Proposed Test Method for Accelerated Detection of Potentially Deleterious Expansion of Mortar Bars Due to Alkali-Silica Reaction," ASTM Designation P214, 1990.

9. "Standard Practice for Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete," ASTM C457

10. Knab, L. I., "Factors Related to the Performance of Concrete Repair Materials," Technical Report REMR-CS-12, U S Army, Waterways Experiment Station, Vicksburg, MS, March 1988.

11. "Report for the Structural Investigation of Steam Manholes - 100% Submission," April 18, 1991, McMullan & Associates, Vienna, VA.

TABLES 1 TO 5

Table 1. Location/ Remarks for Powder Chloride and Core Samples in Building and Building-Related Structures

P = powder sample for chloride analysis
C = core sample for chloride analysis and carbonation depth
SB = subbasement
B = basement
1F, 2F, 3F = first, second, third floor
A = attic
T = already sampled, but not yet analyzed for chloride
N, S, E, W = north, south, east, and west
Exterior = structure exposed to weathering, including pits covered with an open grate.
DC = delaminated concrete and hazard of falling concrete exists; see Appendix A for additional details on delaminated concrete.
Note: entry in brackets under "Location" is height of sample above the floor; within the brackets, metric is shown first in meters separated by a comma and followed by english units in feet.

Spec. No.	Bldg.	Level	Location	Remarks
P116	101	B	Rm. A23, on column [1.2,4]	
P117	101	B	Rm. A23, on column [1.2,4]	
P118	101	B	Rm. A23, on floor	
P119	101	B	near Rm. B05 on E wall, sample near paint scaling	weeps water in spring of year
P120	101	B	about 7.6 m (25 ft) S of Rm. B23, very close to E wall	cracking in slab overhead
P121	101	B	about 7.6 m (25 ft) S of Rm. B23, on bottom of slab	may be difficult to sample due to pipes etc.
P122	101	B	Mechanical Room, D01, on column ACUB3	
P123	101	B	Mechanical Room, D01, on wall, between EB2 blowers	fill on opposite side of wall
P124	101	B	Mechanical Room, D01, on S wall CPB1	fill on opposite side of wall
P125	101	-	loading dock, on W wall of retaining wall [< 1.8, 6]	

Spec. No.	Bldg.	Level	Location	Remarks
P126	101	-	loading dock, on W wall of retaining wall [< 1.8,6]	
P127	101	-	loading dock, on S wall at E end	
P128	101	-	loading dock, on S wall, at W end	
P129	101	-	loading dock, on E column [1.2,4]	
P130	101	-	loading dock, on W column [1.2,4]	
P297	101	1F	west end of tunnel near Credit Union on ceiling near N wall	
P300	101	-	fresh air pits on S side of library, on S wall [.15,.5], SE corner	
P301	101	-	fresh air pits on S side of library, on N exterior foundation wall [.1,.3]	DC; a number of delaminated areas particularly toward the top .25 m (.8 ft) of wall (S wall), 3 of the 4 overhead beams are distressed, beam bottoms (< 1.8 m (6 ft) off floor);
P302	101	-	library, W end of S wall under overhang [2.6,8.5], about 7.3 m (24 ft) from W wall, exterior	delamination at several spots underneath overhang of S wall, 2.6 m (8.5 ft) high; DC removed in 1991
-	101	1F	exterior columns outside of Health Unit need attention	DC; verify if steel shapes

Spec. No.	Bldg.	Level	Location	Remarks
P327	101	-	exterior stairs to guard office on N side of 101	stairs need to be replaced
C21	101	B	Mechanical Room, D01, near column ACUB3, on floor	
C22	101	-	loading dock, on W wall of retaining wall at W end [<1.8,6]	
C23	101	-	loading dock, on S wall of retaining wall about .15 m (.5 ft) off sidewalk	end of S wall of retaining wall may need further evaluation on bottom of wall as it shortens in height
C24	101	-	loading dock, on S wall at center	if core shows no overlay, may take another core
C25	101	-	loading dock, on middle column [1.2,4]	
C54	101	-	fresh air pits on S side of library, on wall [2.1,7], hollow sounding	DC; about 3.1 m (10 ft) of hollow sound near top .15 to .25 m (.5 to .8 ft) of S wall
C55	101		fresh air pits on S side of library, on SE wall [.91,3]	
P276	202	1F	on N side near hot oven, on floor	
P277	202	-	N loading dock, on W wall [.61,2], exterior	
P324	202	-	exterior stairs, NE side of 202, on horizontal step	

Spec. No.	Bldg.	Level	Location	Remarks
C45	202	-	on N exterior foundation wall (just above waterproofing, near N loading dock	.25 m (.83 ft) clearance to core (from sidewalk to bottom of brick)
P295a	205	-	S stairs, exterior	
P131	206	1F	on E wall [.31,1] of third bin from W end of 206	
P132	206	1F	on N wall [.31,1] of third bin from W end of 206	
P135	206	1F	on E wall [.31,1] of second bin from W end of 206	DC
P137	206	1F	on N wall [.31,1] of second bin from W end of 206	DC
P139	206	1F	on W wall [.31,1] of second bin from W end of 206	DC
P142	206	1F	in middle of ceiling [about 3.7,12] of third bin from W end of 206	
P143	206	1F	in middle of ceiling [about 3.7,12] of second bin from W end of 206	
P144	206	1F	in middle of ceiling [about 3.7,12] of second bin from W end of 206	
P145	206	1F	on N wall [3.0,10] of second bin from W end of 206	
P146	206	1F	on E wall [3.0,10] of first bin from W end of 206	DC

Spec. No.	Bldg.	Level	Location	Remarks
P147	206	1F	on N wall [3.0,10] of first bin from W end of 206	DC
P149	206	1F	on E wall [.31,1] of first bin from W end of 206	
P151	206	1F	on N wall [.31,1] of first bin from W end of 206	
P154	206	1F	on W wall [.61,2] of first bin from W end of 206	DC
P157	206	-	near NW stairs [.91,3], on W wall, exterior, near expansion joint	
P158	206	-	near NW stairs [.91,3], on W wall, exterior, near expansion joint	
P159	206	-	at corner at bottom of NW stairs, exterior, crack visible	
P160	206	-	Rm. 104, at W end, on vertical end surface of slab	water from dust collector gets into slab
P168	206	roof	near parapet wall on horizontal surface, exterior	
P170	206	1F	Rm. 107, stone storage bin inside of N wall (take sample from N wall inside of empty bin, where there is soil on other side of wall)	
P171	206	1F	Rm. 107, on S wall [<2.1,7] across from bin #7	

Spec. No.	Bldg.	Level	Location	Remarks
P295	206	2F	parapet wall [4.0,13], side facing W, visible from 2F	roof leak
P296	206	2F	parapet wall [4.0,13], side facing N, visible from 2F, near exposed rebar	roof leak
P315T	206	1F	inside of second bin from west end, on wall, several cm (inches) off floor; near P135;	about 29 to 38 mm (1.125 to 1.5 in) from outside of concrete to edge of steel
P319T	206	-	from W wall of second bin from west end on the upper level, (access from the roof area)	check DC; severely delaminated concrete removed in fall 1991, verify as W wall
P319a	206	-	from ceiling of second bin from west end on the upper level, (access from the roof area)	check DC
P319b	206	-	from floor of second bin from west end on the upper level, (access from the roof area)	
P319c	206	-	from W wall of first bin from west end on the upper level, (access from the roof area)	
P319d	206	-	from floor of first bin from west end on the upper level, (access from the roof area)	
P319e	206	-	from floor of third bin from west end on the upper level, (access from the roof area)	

Spec. No.	Bldg.	Level	Location	Remarks
P319f	206	-	from E wall of third bin from west end on the upper level, (access from the roof area)	
P319g	206	-	from ceiling of first bin from west end on the upper level, (access from the roof area)	
P319h	206	-	from ceiling of third bin from west end on the upper level, (access from the roof area)	
C28	206	1F	on E wall [.61,2] of second bin from W end of 206; core completely through wall and get chloride samples and carbonation depth on both sides of the wall (both ends of core)	check DC; core location and length (completely through wall) must be approved by structural engineer
C29	206	1F	on E wall [.61,2] of first bin from W end of 206; core completely through wall and get chloride samples and carbonation depth on both sides of the wall (both ends of core)	core location and length (completely through wall) must be approved by structural engineer
C31	206	1F	on W wall [.61,2] of first bin from W end of 206; core .15 m (.5 ft) into wall	core location and length (.15 m (.5 ft)) must be approved by structural engineer

Spec. No.	Bldg.	Level	Location	Remarks
C31a	206	-	on W wall of second bin from west end on the upper level, access from the roof area; take core slightly below spalled areas; core completely through wall; take chloride samples and carbonation depth from both sides of wall (both ends of core).	check DC; severely delaminated concrete removed in fall 1991, verify as W wall; not marked; core location and length (completely through wall) must be approved by structural engineer
C31b	206	-	on E wall of second bin from west end on the upper level, access from the roof area; take core in delaminated area; core completely through wall; take chloride samples and carbonation depth from both sides of wall (both ends of core).	check DC; not marked; core location and length (completely through wall) must be approved by structural engineer
P230	220	1F	Rm A103, N loading dock, in NW corner about 1.8 m (6 ft) from W wall on ceiling [3.3,11] near paint peeling	
P231	220	1F	Rm A103, N loading dock, on beam bottom, about 1.2 m (4 ft) from W wall near paint peeling	
P232	220	-	Rm. C09, Transformer Room, on vertical surface of beam column joint [3.0,10] on S wall, behind switch gear, avoid sampling patched area	note diagonal crack in adjacent reinforced beam; check for DC at patched area

Spec. No.	Bldg.	Level	Location	Remarks
P233	220	-	Rm. C09, Transformer Room, on W wall [.91,3]	
P234	220	-	mechanical room, on N wall [.61,2], near construction joint and air compressor	construction joint on N wall needs attention
P235	220	-	mechanical room, on N wall [2.1-2.4,7-8], on W side of construction joint, near air compressor	
P235a	220	-	Rm. C09, Transformer Room, on girder or beam [2.7,9], above door, about 1.5 m (5 ft) N	
P236	220	-	mechanical room, on N wall [2.1-2.4,7-8], on E side of construction joint, near air compressor	
P237	220	B	Rm C08, on W wall [1.2,4], by E15 exhaust fan	
P238	220	SB	Service Entry Room, on N wall [2.4,8]	
P239	220	B	S stairwell, on ceiling [3.3,11]	below grade
P240	220	3F	S stairwell, on ceiling slab [5.2,17], near crack	
P241	220	3F	S stairwell, on ceiling slab [3.3,11], near crack	
P242	220	3F	N stairwell, on ceiling slab [3.3,11], near crack	

Spec. No.	Bldg.	Level	Location	Remarks
P243	220	3F	N stairwell, on ceiling slab [5.2,17], near crack	
P244	220	A	S side of 220, 1.2 m (4 ft) S of Column 29, on floor	
P245	220	A	S side of 220, on ceiling [3.7,12], about 3.0 m (10 ft) S of Column 29	
P246	220	A	about 6.1 m (20 ft) S of elevator on E side of 220, on ceiling [3.7,12], near RU2	
P326	220	-	Fresh Air intake pit on E side of Bldg. 220, access from Mechanical Room, C08. On S wall of pit (take sample near .05 sq m (1/2 sf) delamination about 3.3 m (11 ft) off floor).	DC
P327	220	-	Mechanical Room C08, on W wall [.31,1]	Active water leak seeping water and mud; mud on floor.
P328	220	-	Mechanical Room C08, on ceiling [3.7,12] near S wall. Take sample near apparent rust stain on ceiling.	
P329	220	-	Mechanical Room C08, on S wall [1.8,6]	
P330	220	-	Air intake pit on SW corner of Bldg. 220, on N wall about .61 m (2 ft) from top of pit and in the middle of the N wall, in the E-W direction.	pit was visually inspected from the top only

Spec. No.	Bldg.	Level	Location	Remarks
C38	220	-	Service Entry Room, on N wall [.91,3]	about .25 m (.83 ft) deep core
P205	221	SB	Service Entry Rm, NW corner of 221, on floor at E corner on scabbed area	
P206	221	SB	Service Entry Rm, NW corner of 221, on ceiling [3.3,11] near cracks	
P207	221	3F	N stairwell, on 3F ceiling slab [3.3,11], sample near crack	
P208	221	3F	N stairwell, on 3F ceiling slab [5.2,17], sample near crack	
P209	221	3F	S stairwell, on 3F ceiling slab [3.3,11], sample near crack	cracks are pronounced
P209	221	3F	S stairwell, on 3F ceiling slab [5.2,17], sample near crack	cracks are pronounced
P211	221	A	Telephone Rm., SW corner, on W wall [2.7,9]	fill on other side
P212	221	B	E end of Rm. C06, on ceiling [3.3,11]	about .6 m (2 ft) below grade, water enters when rains
P213	221	A	near N wall on ceiling [3.7,12], near ACU11, near Column 29	
P211	221	A	about .91 m (3 ft) from N wall on ceiling [3.7,12]	
P215	221	1F	loading dock, SE bay, on ceiling [3.7,12], take sample where paint is peeling	

Spec. No.	Bldg.	Level	Location	Remarks
P216	221	1F	loading dock, SE bay, on vertical side of beam [3.7,12], take sample where paint is peeling	
C35	221	-	Service Entry Rm, NW corner of 221, on W wall [.61,2] near door	do not core through wall, fill on other side of wall,.15 m (.5 ft) core length should be ok. Note: hollow sound in corner on W wall, .61 to .91 m (2 to 3 ft) off floor, no visual distress
C36	221	B	Telephone Rm., SW corner, on W wall (about 1.1 m (3.7 ft) off floor),	do not core through wall, fill on other side of wall, .15 m (.5 ft) core length should be ok.
P217	222	-	W end of 222, Service Entry Rm., W wall [.61,2]	fill behind wall
P218	222	-	N side of 222, Rm A01 telephone closet, on beam bottom [3.3,11], sample close to exposed rebar	take this sample only if core C37a cannot be taken; DC; some DC removed in 1991, more DC needs to be removed
P219	222	-	N side of 222, Rm A01 telephone closet, on W wall [2.4,8]	
P220	222	3F	S stairwell, on ceiling slab [3.3,11], near cracks , if possible	

Spec. No.	Bldg.	Level	Location	Remarks
P221	222	3F	S stairwell, on ceiling slab [5.2,17], near cracks , if possible	
P222	222	3F	N stairwell, on ceiling slab [3.3,11], near cracks , if possible	
P223	222	3F	N stairwell, on ceiling slab [5.2,17], near cracks, if possible	
P224	222	1F	loading dock, Rm. B102, near center of W wall on ceiling [3.3,11] and 3.7 m (12 ft) E of W wall near water mark and crack	
P225	222	1F	loading dock, Rm. B102, on ceiling [3.3,11], about 2.4 m (8 ft) W of E wall, near paint chips	
P226	222	A	near elevator at E wall, about 1.2 m (4 ft) W of E wall on ceiling [3.3,11] near rust stains	
P227	222	A	on floor by water marks, about 1.5 m (5 ft) from Column 29 on S side of 222	
P228	222	A	on ceiling [3.3,11], close to S wall and somewhat close to Column 29	
P229	222	A	on ceiling [3.3,11], about 3.0 m (10 ft) N of Column 29 on N side of building, near ACU10	

Spec. No.	Bldg.	Level	Location	Remarks
C37	222	-	N side of 222, Rm A 01 telephone closet, E wall [.31,1]	wall seepage
37a	222	-	N side of 222, Rm A01, telephone closet, on beam bottom [3.3,11], core close to exposed rebar	if unable to take this sample, then take powder P218; DC; some DC removed in 1991, more DC needs to be removed
P193	223	3F	N stairwell, on 3F ceiling slab [3.3,11], sample near crack	
P194	223	3F	N stairwell, on 3F ceiling slab [5.2,17], sample near crack	
P195	223	3F	S stairwell, on 3F ceiling slab [3.3,11], sample near crack	
P196	223	3F	S stairwell, on 3F ceiling slab [5.2,17], sample near crack	
P197	223	-	Mechanical Room, below Rm. A103, on ceiling bottom at SE corner [3.2,10.5]	
P198	223	-	Mechanical Room, below Rm. A103, on wall [.61,2] in SE corner	
P199	223	-	Rm. B01, N section, on beam bottom [3.3,11]	
P200	223	-	Rm. B01, N section, on E wall [2.4,8]	fill behind wall
P201	223	A	S ACU9, on ceiling [3.7,12]	
P202	223	A	near column 29, 1.2 m (4 ft) from col 29 on floor, on S side of 223	

Spec. No.	Bldg.	Level	Location	Remarks
P203	223	A	near column 29, 1.8 m (6 ft) from col 29 on ceiling, on N side of 223	
P204	223	A	on ceiling [3.7,12], above SMP6, in NW corner near crack	
C34	223	-	Rm. B01, S section, on W wall [.61,2]	fill behind wall
P75	224	SB	Rm. A008 on W wall [3.4,11]	
P92	224	-	Rm. B001, Service Entry Room, on N wall	fill behind wall
P93	224	-	inner room of Rm. A02, on S wall, under parging	fill behind wall
P94	224	-	inner room of Rm. A02, on W wall	fill behind wall
P95	224	-	outer room of Rm. A02, on W wall	fill behind wall
P96	224	1F	loading dock, on slab ceiling by center column	
P97	224	1F	loading dock, S end, on ceiling slab	
P98	224	1F	loading dock, S end, on beam bottom	
P99	224	1F	loading dock, N end, on ceiling slab	
P100	224	1F	loading dock, E end, on ceiling slab	
P101	224	3F	N stairwell, on 3F ceiling, sample near crack on W end	cracking on slab bottom
P102	224	3F	N stairwell, on 3F ceiling, sample near crack on E end	cracking on slab bottom

Spec. No.	Bldg.	Level	Location	Remarks
P103	224	A	on ceiling about 1.8 m (6 ft) N of column 29 on N side of 224	water on floor
P104	224	A	on floor about .61 m (2 ft) N of column 29 on N side of 224	water on floor
P105	224	A	on ceiling about 1.8 m (6 ft) S of column 29 on S side of 224	water on floor
P106	224	A	on floor about .91 m (3 ft) S of column 29 on S side of 224	water on floor
P107	224	3F	S stairwell, on 3F ceiling, sample near crack on E end	cracking on slab bottom
P108	224	3F	S stairwell, on 3F ceiling, sample near crack on W end	cracking on slab bottom
P299	224	1F	exterior foundation wall, SE corner near outside steps, remove parging to sample concrete, sample just above the waterproofing	
P308	224	1F	on N exterior foundation wall, just above the waterproofing	
C19	224	-	Rm. B001, Service Entry Room, on W wall	fill behind wall
C20	224	-	inner room of Rm. A02, on E wall on parging	fill behind wall
P109	225	3F	S stairwell, on 3F ceiling slab [3.3,11], sample near crack on W end	cracking on slab bottom
P110	225	3F	S stairwell, on 3F ceiling slab [5.2,17], sample near crack on E end	cracking on slab bottom

Spec. No.	Bldg.	Level	Location	Remarks
P111	225	3F	N stairwell, on 3F ceiling slab [3.3,11], sample near crack on E end	cracking on slab bottom
P112	225	3F	N stairwell, on 3F ceiling slab [5.2,17], sample near crack on W end	cracking on slab bottom
P113	225	A	on ceiling about 1.8 m (6 ft) N of column 29 on N side of 225	water on floor
P114	225	A	on floor about 1.8 m (6 ft) N of column 29 on N side of 225	water on floor
P115	225	A	on ceiling about 3.0 m (10 ft) S of column 29 on S side of 225	
P181	225	-	Electrical Breaker Room, SE corner of 225, on N wall [<2.1,7]	fill on other side of wall,wall about 12 inches thick
P182	225	1F	Rm. A103, loading dock, bottom of ceiling slab [3.0,10], center	flat roof above
P183	225	-	concourse between 225 and library, on third column from 225 [1.8,6], W side; exterior	columns may be steel shapes; if so, reduce column samples from 3 to 1
P184	225	-	concourse between 225 and library, on underside of ceiling [2.7,9] at third column from 225, W side; exterior	
P185	225	-	concourse between 225 and library, on sixth column from library [1.8,6], W side; exterior	columns may be steel shapes; if so, reduce column samples from 3 to 1

Spec. No.	Bldg.	Level	Location	Remarks
P186	225	-	concourse between 225 and library, on underside of ceiling [2.7,9] at sixth column from library, W side; exterior	
P187	225	-	concourse between 225 and library, on third column from library [1.8,6], W side; exterior	columns may be steel shapes; if so, reduce column samples from 3 to 1
P188	225	-	concourse between 225 and library, on under-side of ceiling [2.7,9] at third column from library W side; exterior	
P189	225	-	concourse between 225 and library, on sidewalk at third column from library [1.8,6], W side; exterior	
P190	225	-	concourse between 225 and library, on vertical wall facing W (at elevation below sidewalk) at third column from library; exterior	
P191	225	-	concourse between 225 and library, on sidewalk, at fifth column from 225, W side; exterior	
P192	225	-	near middle of concourse between 225 and library, on W ramp; exterior	
P298	225	1F	Rm. A103, loading dock, underside of N canopy [3.3,11]; exterior	flat roof above

Spec. No.	Bldg.	Level	Location	Remarks
P306	225	1F	W exterior foundation wall, about 15 m (50 ft) S of nitrogen storage tank, just above the waterproofing	
P309	225	1F	on E exterior foundation wall, at SE corner, just above waterproofing	hollow spot about .1x.1 m (4x4 in), near P309
C32	225	-	Electrical Breaker Room, SE corner of 225, on E wall [<2.1,7], in telephone room	fill on other side of wall; wall about .31 m (1.0 ft) thick
C33	225	-	concourse between 225 and library, near fifth column from library, under walkway on W side; exterior	
P84	226	A	On floor, on N side of 226, near column 29	
P85	226	A	On ceiling [3.7,12], on N side of ACU6	
P86	226	3F	N stairwell, on ceiling slab [3.3,11] on E end	cracking on bottom of slab
P87	226	3F	N stairwell, on ceiling slab [5.2,17] on W end	cracking on bottom of slab
P88	226	-	mechanical room, on W wall	
P89	226	-	mechanical room, on S wall	
P90	226	-	Rm. B03, on beam bottom [3.7,12]	area showing corrosion, fill on top of beam, DC; DC removed 1991
P91	226	-	entry into Rm. B03, on W wall	fill behind wall

Spec. No.	Bldg.	Level	Location	Remarks
P307	226	1F	on S exterior foundation wall, near E corner, just above waterproofing	
-	226	Be-tween attic and roof	several treads on W stairs are badly chipped and need to be repaired to prevent tripping	
C17	226		Rm. B03, inner room, beam bottom [3.7,12], beam bottom is about .31 m (1.0 ft) wide	may need hand held coring apparatus, area showing corrosion, fill on top of beam, DC; DC removed 1991 - note presence of one large void on ceiling, on bottom of removable slab
C18	226	-	Rm. B03, inner room, on parging, on W wall	fill behind wall
P278	230	-	fresh air pit, on SW side of 230, on horizontal surface, exterior exposure on ground level	
P279	230	-	NW fresh air pit, horizontal surface, exterior exposure on ground level	
P281	230	-	Rm. 06, NW corner on W wall [.61,2]	fill on other side of wall, thin crack
P282	230	-	stairwell from Rm.06 to Rm.07, SW corner on W wall [.61,2]	fill on other side
P283	230	-	N pit, access from transformer room, on N wall of pit [.61,2]; exterior	fill on other side of pit

Spec. No.	Bldg.	Level	Location	Remarks
P284	230	-	N pit, access from Transformer Room, on floor on W end of pit by drain; exterior	water standing on W half of pit floor
P285	230	-	on S wall [2.1,7] of Transformer Room, in middle of wall (in E-W direction)	visible water entry due to pipe penetrations
P286	230	-	on N wall [.31,1] of Transformer Room, NW corner	
P287	230	-	Rm. C04, on E wall [.61,2], in NE corner	efflorescence on wall
P288	230	-	fresh air intake pit on NW corner of 230, off Rm. C04, on E wall [.31,1] near entry door; exterior	DC; DC removed in 1991
P289	230	-	fresh air intake pit on NW corner of 230, off Rm. C04, on bottom of beam (about 6.1 m (20 ft) off floor, about .31 m (1 ft) from top of pit), beam to S on top of pit, take sample at midspan, i.e., midway between E and W pit walls; exterior	check for DC on bottom of beam
P290	230	-	fresh air intake pit on NW corner of 230, off Rm. C04, on E wall [3.0,10] near N end of pit; exterior	DC; DC removed 1991
P291	230	-	fresh air intake pit on NW corner of 230, off Rm. C04, on E wall (about 6.1 m (20 ft) from floor and about .61 m (2 ft) from top of pit) near N end of pit; exterior	DC; DC removed 1991

Spec. No.	Bldg.	Level	Location	Remarks
P292	230	-	fresh air intake pit on NW corner of 230, off Rm. C04, on N wall [1.2,4]; exterior	fill on other side of wall
P293	230	-	fresh air intake pit on NW corner of 230, off Rm. C04, on W wall [4.0,13], in center of wall; exterior	fill on other side of wall
P294	230	-	fresh air intake pit on NW corner of 230, off Rm. C04, on W wall [.15,.5], at SW corner; exterior	fill on other side of wall
P296b	230	-	fresh air pit just S of the NW pit (adjacent to NW pit), on W wall [1.7,5.5] in SW corner; exterior	Note: major delamination, 1.2 to 1.8 m (4 to 6 ft) off floor, by entrance ladder (SE corner); DC (scheduled to be removed in 1991 but was not); small amount of rebar exposed on center of E wall
P296c	230	-	SW fresh air pit, E wall (.31 m (1 ft) off upper level floor); exterior	
P297a	230	-	SW fresh air pit, SW corner, W wall (.15 m (.5 ft)) off floor on lower level); exterior	
P314T	230	-	NW fresh air pit, near north side of door on east wall; exterior	DC; DC removed 1991; about 25 to 32 mm (1 to 1.25 in) from outside of concrete to edge of steel

Spec. No.	Bldg.	Level	Location	Remarks
-	230	-	Outdoor pump house on the SE side of Bldg. 230.; structure not inspected due to .31-.38 m (1-1.25 ft) water in floor; wooden ladders in water should be inspected for rot before being used.	If personnel are going to be in this structure, it should inspected; 1.2 m (4 ft) deep blower pit on W side of pump house appeared satisfactory
C46	230	-	exterior foundation wall [.11,.38], at SW corner	.23 m (.75 ft) vertical workspace, not parged (original concrete)
C49	230	-	fresh air intake pit on NW corner of 230, off Rm. C04, on E wall [2.1,7], near entry door with severe dalamination; exterior	DC; DC removed in 1991
C50	230	-	fresh air intake pit on NW corner of 230, off Rm. C04, on S wall [.89,2.9], on delamination at hollow sound; exterior	
C52	230	-	fresh air pit just S of the NW pit (adjacent to NW pit), on dividing wall [1.5,5] between the NW pit and pit just S of NW pit; exterior	four minor sized hollow spots, no visible delamination; check DC
C53	230	-	fresh air pit just S of the NW pit (adjacent to NW pit), on S wall [1.7,5.5]; exterior	

Spec. No.	Bldg.	Level	Location	Remarks
P28	231	1F	Rm. A169 Sump; underside of slab in northernmost bay at NW corner (about 2.4 m (8 ft) above steel grate)	See March 15, 1991 memorandum to Plant Division; check DC; Note: May not need P28 because core C2 in same location
P29	231	1F	Rm. A169 Sump; underside of slab in center(N-S) bay on W side (about 2.4 m (8 ft) above steel grate)	check DC; Note: may not need P29 because core C3 in same location.
P30	231	1F	Rm. A169 Sump; underside of slab in southernmost bay on W side (about 2.4 m (8 ft) above steel grate)	check DC; Note: may not need P30 because C4 in same location.
P31	231	1F	Rm. A169 Sump; underside or side of northernmost beam on W side (beam runs E and W) (about 2.4 m (8 ft) above steel grate)	check DC
P32	231	1F	Rm. A169 Sump; underside or side of middle (second from north end of room) beam (beam runs E and W) on W side (about 2.4 m (8 ft) above steel grate)	check DC
P33	231	1F	Rm. A169 Sump; underside or side of middle (second from south end of room) beam (beam runs E and W) on W side (about 2.4 m (8 ft) above steel grate)	check DC

Spec. No.	Bldg.	Level	Location	Remarks
P34	231	1F	Rm. A169 Sump; underside or side of southernmost beam (beam runs E and W) on W side (about 2.4 m (8 ft) above steel grate)	check DC
P35	231	1F	Rm. A169 Sump; underside of slab in northernmost bay near slab center (E-W) (about 2.4 m (8 ft) above steel grate)	check DC
P36	231	1F	Rm. A169 Sump; underside of slab in center (N-S) bay near slab center (E-W) (about 2.4 m (8 ft) above steel grate)	check DC
P37	231	1F	Rm. A169 Sump; underside of slab in southernmost bay near slab center (E-W) (about 2.4 m (8 ft) above steel grate)	check DC
P38	231	1F	Rm. A169 Sump; underside of slab in northernmost bay on E side (about 2.4 m (8 ft) above steel grate)	check DC
P39	231	1F	Rm. A169 Sump; underside of slab in center (N-S) bay near E side (about 2.4 m (8 ft) above steel grate)	check DC
P40	231	1F	Rm. A169 Sump; underside of slab in southernmost bay near E side (about 2.4 m (8 ft) above steel grate)	check DC

Spec. No.	Bldg.	Level	Location	Remarks
P41	231	1F	Rm. A169 Sump; underside or side of northernmost beam on E side (beam runs E and W) (about 2.4 m (8 ft) above steel grate)	check DC
P42	231	1F	Rm. A169 Sump; underside or side of middle (second from north end of room) beam (beam runs E and W) on E side (about 2.4 m (8 ft) above steel grate)	check DC
P43	231	1F	Rm. A169 Sump; underside or side of middle (second from south end of room) beam (beam runs E and W) on E side (about 2.4 m (8 ft) above steel grate)	check DC
P44	231	1F	Rm. A169 Sump; underside or side of southernmost beam (beam runs E and W) on E side (about 2.4 m (8 ft) above steel grate)	check DC
P45	231	1F	Rm. A169; SE, not sure if wall etc.	check DC
P46	231	1F	Rm. A169; S, near crack on slab bottom (need to get height off floor)	check DC
P47	231	1F	Rm. A169; N, near crack on slab bottom (need to get height off floor)	check DC
P48	231	1F	Rm. A169; N, on girder bottom (need to get height off floor)	check DC

Spec. No.	Bldg.	Level	Location	Remarks
P49	231	1F	Rm. A169; N, on girder bottom (need to get height off floor)	check DC
P50	231	1F	Rm. A169; NE, on girder bottom, near water stain (need to get height)	check DC
P79	231	-	W stairwell, entrance to mechanical room, on ceiling [4.3,14], exterior	DC; DC removed in 1991
P80	231	-	W stairwell, on ceiling [2.4,8] in tunnel near mechanical room, exterior	
P81	231	-	W stairwell, on ceiling [2.4,8], near S end of tunnel, exterior	
P82	231	-	W stairwell, on ceiling [2.4,8], at S end of tunnel, exterior	
P83	231	-	W stairwell, on wall [1.5,5] at S end of tunnel, exterior	
P303	231	-	W stairwell, on vertical riser, upper stairs, exterior	
P304	231	-	SW fresh air pit, S face of overhead of fresh air tunnel, 1.8 m (6 ft) off floor on vertical face, exterior	
P305	231	-	SW fresh air pit, on E wall [.15,.5], exterior	
P322	231	-	NW fresh air pit on W wall [1.2,4], B Wing, exterior	

Spec. No.	Bldg.	Level	Location	Remarks
P323	231	-	Rm B32, NE corner on N wall [.91,3]	
C2	231	1F	Rm. A169 Sump; underside of slab in northernmost bay at NW corner (about 2.4 m (8 ft) above steel grate)	check DC
C3	231	1F	Rm. A169 Sump; underside of slab in center(N-S) bay on W side (about 2.4 m (8 ft) above steel grate)	check DC
C4	231	1F	Rm. A169 Sump; underside of slab in southernmost bay on W side (about 2.4 m (8 ft) above steel grate)	check DC
C5	231	1F	Rm. A169 Sump; underside of slab in northernmost bay near slab center (E-W) (about 2.4 m (8 ft) above steel grate)	check DC
C6	231	1F	Rm. A169 Sump; underside of slab in center (N-S) bay, near slab center (E-W) (about 2.4 m (8 ft) above steel grate)	check DC
C7	231	1F	Rm. A169 Sump; underside of slab in southernmost bay, near slab center (E-W) (about 2.4 m (8 ft) above steel grate)	check DC

Spec. No.	Bldg.	Level	Location	Remarks
C16	231	-	W stairwell, entrance to mechanical room, on ceiling [4.3,14]; exterior	DC; DC removed in 1991
P250	233	1F	Rm. A121, on S wall [2.4,8], on water stains	DC; DC removed in 1991
P251	233	-	Rm. A129, on E wall [.31,1] in NE corner	
P310	233	1F	exterior foundation wall on N side of 233 near NE door, just above waterproofing	
P317T	233	-	center of Rm A121, near Rm A 124, close to roof drain, taken from ceiling	
P318T	233	-	southwest corner of Rm A121, from ceiling, obtained from removal of delaminated concrete	DC; DC removed in 1991; visible corrosion damage; about 25 mm (1 in) from outside of concrete to edge of steel
P320T	233		southeast corner of Rm A121, from ceiling, obtained from removal of delaminated concrete	DC; DC removed in 1991; visible corrosion damage; about 22 mm (7/8 in) from outside of concrete to edge of steel

Spec. No.	Bldg.	Level	Location	Remarks
P321T	233	-	middle of south wall on ceiling of Rm A121, obtained from removal of delaminated concrete	DC; DC removed in 1991; visible corrosion damage; about 25 mm (1 in) from outside of concrete to edge of steel
P325	233	-	Rm B01, NE corner on ceiling [3.0,10]	soil over ceiling
P326	233	-	on exterior foundation wall, on NE side of 233, near NE door	
P331	233	-	High Voltage Pit on NE side of Bldg. 233, in room with steam pipes, on E wall [.61,2]	
P332	233	-	High Voltage Pit on NE side of Bldg. 233, in main chamber, on W wall [2.4,8]	Standing water on floor of main chamber
P333	233	-	High Voltage Pit on NE side of Bldg. 233, in N compartment of main chamber on ceiling [about 4.3,14] in center of ceiling in N-S direction; exterior.	
P334	233	-	High Voltage Pit on NE side of Bldg. 233, in N compartment of main chamber on E wall [about 4.0,13]; exterior	
P280	235	-	exterior W wall, confinement building, orignal construction	concrete spalled off rebar
C47	235	-	Rm. D01 Pump Room, near Pump #1	

Spec. No.	Bldg.	Level	Location	Remarks
C48	235	-	Rm. D01 Pump Room, on ceiling [3.7,12] over Pump #3, near delamination	DC; DC removed in 1991
C56T	235	1F	3.0 m (10 ft) W of Rm. D100 (just outside of door to D100)	core taken (146 mm (5.75 in) in diameter);
C57T	235	1F	3.0 m (10 ft) W of Rm. D100 (just outside of door to D100)	core taken (95 mm (3.75 in) in diameter)
C58T	235	1F	N side of Rm. D100, on floor	core taken (146 mm (5.75 in) in diameter)
C59T	235	1F	NW corner of Rm. D100 on W wall [2.4,8]	core taken (95 mm (3.75 in) in diameter)
C60T	235	1F	NW corner of Rm. D100 on W wall [2.4,8]	core taken (95 mm, 3.75 in) in diameter)
C61T	235	-	probable location: N wall [2.7,9] of Rm. D100	core taken (121 mm (4.75 in) in diameter)
Note	235	SB	Rm. C006 on N wall; wall appears to be bubbled out, possibly delaminated; could not get close enough to discern	This is a high radiation area; should be inspected when safe to do so and, if necessary, a powder or core taken, check for DC
P172	236	-	Mechanical Rm 04, on E wall [1.2,4]	
P173	236	-	Mechanical Rm 04, on E wall [3.0,10]	
P174	236	-	Mechanical Rm 04, on W wall [1.2,4]	
P175	236	-	on E wall [1.2,4] of E extension, exterior	

Spec. No.	Bldg.	Level	Location	Remarks
P176	236	1F	on N wall [3.0,10] Rm. 105, near ceiling, near leaking crack	
P177	236	roof	N side of 236, exterior, on horizontal underside of parapet wall [4.6,15], fourth bay from E end	DC
P178	236	-	N side of 236, exterior, on fifth pilaster [1.2,4] from E end	
P179	236	roof	N side of 236, exterior, on middle of vertical surface of parapet wall [4.9,16], fourth bay from E end	may not be needed if C51 taken
P180	236	-	on W exterior wall [1.8,6] of 236	
P296a	236	roof	concrete fan base [.1,.3], sixth fan from W end, on high roof, exterior	
C51	236	roof	exterior, horizontal surface of parapet wall, or if possible, vertical surface of parapet wall, seventh pilaster from E end	
P1	245	SB	S of Rm B038 on wall [<2.1,7]	active water leak
P2	245	SB	W of Rm B039 on wall [<2.1,7]	active water leak
P3	245	SB	E of Rm B040 on wall [<2.1,7]	active water leak

Spec. No.	Bldg.	Level	Location	Remarks
P4	245	SB	3.0 m (10 ft) S of Rm B041 on bottom of northernmost beam [3.0,10]	beam exposed to water apparently coming between A Wing and B Wing walls; water most likely coming from fill; DC
P5	245	SB	3.7 m (12 ft) S of Rm B041 on bottom of southernmost beam [3.0,10], in A Corridor.	beam exposed to water apparently coming between A Wing and B Wing walls; water most likely coming from fill.
P6	245	SB	near Rm A006 on bottom of slab near water stains [3.7,12]	active water leak
P7	245	be-tween SB and B	on S wall, beside freight elevator in B Wing [<2.1,7].	most likely fed by water coming between A Wing and B Wing walls
P8	245	B	in basement on wall in E corridor, 1.5 m (5 ft) N of Rm. A 018 [<2.1,7]	chemically grouted - still leaks a little, may be lead dust in the concrete
P9	245	B	on N wall in E corridor in B, 9.1 m (30 ft) E of Rm. A 018 [<2.1,7].	
P10	245	B	on S wall in E corridor in B, 10.7 m (35 ft) E of Rm. A 018 [<2.1,7]	
P11	245	B	3.0 m (10 ft) S of Rm A007 (goes down to SB) on E wall [<2.1,7]	crack visible (possibly a duct chase - maybe lead dust in crack)

Spec. No.	Bldg.	Level	Location	Remarks
P12	245	B	on W wall [<2.1,7], about 3.0 m (10 ft) from gate and about 9.1 m (30 ft) from Rm A007	1.60 mm (1/16 in) maximum width vertical crack, backfill on other side of wall
P13	245	B	about 3.0 m (10 ft) from P12, W wall [<2.1,7]	water weep hole, backfill on other side of wall
P14	245	SB	on E wall [<2.1,7], near N end of tunnel, Rm. A018	
P15	245	SB	on E wall [<2.1,7], near S end of tunnel, Rm A018	no soil around
P16	245	SB	on N wall [<2.1,7] at NW corner of Rm. A018	2.4 to 3.7 m (8 to 12 ft) thick wall, with no fill on other side, probably not active with regard to moisture
P17	245	SB	on W wall [<2.1,7] at S end of tunnel in Rm A018	fill behind wall
P18	245	1F	SE loading dock, A Wing, Rm. A120, on east and bottom side of southernmost beam [4.6,15]	need to determine if steel shape or reinforced concrete
P19	245	1F	SE loading dock, A Wing, Rm. A120, on west and bottom side of southernmost beam [4.6,15]	need to determine if steel shape or reinforced concrete

Spec. No.	Bldg.	Level	Location	Remarks
P20 delete; see P316T	245	1F	SE loading dock, A Wing, Rm. A120, on top of southernmost column [4.3,14]	DC; DC was removed in 1991; need to determine if steel shape or reinforced concrete
P21	245	1F	SE loading dock, A Wing, Rm. A120, on bottom of southernmost column [.31,1]	need to determine if steel shape or reinforced concrete
P51	245	-	A Wing, SW Loading Dock, near Rm. A100, middle of W wall [<1.5,5], exterior	
P52	245	-	A Wing, SW Loading Dock, near Rm. A100, on inside of stairs on W wall [<1.5, 5], exterior	
P58	245	-	SW loading dock, on ramp, exterior	
P53	245	1F	Rm. A100, 5th girder from W end (about in center in E-W direction), on girder bottom [4.3,14]	
P54	245	1F	Rm. A100, SW corner on girder [4.3,14]	
P54a	245	1F	Rm. A100, W end, slab bottom	
P55	245	1F	Rm. A100, Central region (with respect to E-W), on slab bottom, "visually deteriorated"	check DC
P56	245	1F	Rm. A100, E end, on girder bottom	

Spec. No.	Bldg.	Level	Location	Remarks
7	245	-	Stairwell leading to Rm. A108 (wall? [<2.1, 7]?)	
P59	245	-	SW corner, exterior, D Wing	
P60	245	1F	exterior stairs on W loading dock, sample taken on the inside of the stairs (close to ground level)	
P61	245	1F	NE loading dock, on S wall at W end [<2.1,7], exterior	
P62	245	1F	NE loading dock, on W wall at N end [<2.1,7], exterior	
P63	245	1F	NE loading dock, on S wall at E end [<2.1,7], exterior	
P64	245	1F	NE loading dock, on W slab at S end , exterior	
P65	245	1F	NE loading dock, on W slab at N end, exterior	
P66	245	1F	NE loading dock, on W wall at S end, exterior	
P67	245	1F	NE loading dock, on W slab at S end, exterior	
P68	245	1F	NE loading dock, on S slab near W end, exterior	
P69	245	SB	Rm. A006 on S wall [2.7,9]	
P70	245	SB	Rm. A006 on ceiling in SE corner [3.3,11]	

Spec. No.	Bldg.	Level	Location	Remarks
P71	245	SB	Rm. A007 on N wall [2.1,7]	DC (check)
P72	245	SB	Rm. A008 on E wall [3.3,11], toward SE side,	soil behind E wall only
P73	245	SB	Rm. A008 on E wall [3.3,11], toward NE side	DC; badly delaminated
P74	245	SB	Rm. A008 on S wall [3.3,11]	DC; badly delaminated
P75	245	SB	Rm. A008 on W wall [3.3,11]	DC; badly delaminated
P76	245	SB	Rm. A008 on N wall [3.3,11]	DC; badly delaminated
P77	245	SB	Rm. A008 on N wall [2.1,7], (below W wall)	DC; badly delaminated
P78	245	SB	Rm. A008 on bottom (horizontal plane) of W wall [2.4,8]	DC; badly delaminated
P161	245	B	Rm. A10, on S wall [2.7,9]	
P162	245	B	Rm. A10, on S wall [1.5,5]	
P163	245	B	Rm. A10, on S wall [.61,2]	
P164	245	B	Rm. A10, on ceiling W of crack, about .31 m (1 ft) from S wall	
P165	245	B	Rm. A10, on ceiling E of crack, about .31 m (1 ft) from S wall	
P166	245	B	Rm. A10, on N wall [1.5,5]	
P167	245	B	Rm. A10, on S wall [.91,3] at W end, near patched crack	

Spec. No.	Bldg.	Level	Location	Remarks
P316T	245	1F	Rm. A 120, SE loading dock, on top and from side of center column, about 4.3 m (14 ft) off floor	DC; DC removed in 1991; apparently steel shape with fireproofing; whitish appearing sample checked twice for possible asbestos; no asbestos found
P325T Note: there is also a P325 in Bldg. 233	245	1F	Exterior foundation W middle wall	several delaminated areas along W wall- areas about .05 m (1/2 sf) in size
C1	245	SB	bottom of beam, northernmost beam, about 3.1 m (10 ft) south of Rm. B041 [3.1,10]	
C8	245	-	A Wing, SW Loading Dock, near Rm. A100, on inside of stairs on W wall or move location on W wall to a slightly higher and also a more southerly position.... to a visually more distressed area to determine if entrained air is present (< 1.5 m (5 ft) off ground); exterior	SW loading dock was recommended to be replaced (see Table 4, Rank H-3); the determination of the presence or lack of entrained air is to learn of the mechanism of failure; see Sections 3.1.4 and 3.2.1 in report body
C9	245	1F	NE loading dock, on S wall near center (E-W) [<2.1,7]; exterior	

Spec. No.	Bldg.	Level	Location	Remarks
C15	245	1F	NE loading dock, on W wall near center(N-S) [<2.1,7]; exterior	
C11	245	1F	NE loading dock, on W slab near center(N-S) [<2.1,7]; exterior	
C12	245	1F	NE loading dock, on S slab near center(E-W) [<2.1,7]; exterior	
C13	245	SB	Rm. A006 on S wall [2.7,9] (4.3 m (14 ft) maximum dimension to position coring apparatus)	
C14	245	SB	Rm. A008 on E wall [3.3,11] near center (N-S)	
C15	245	SB	Rm. A008 on W wall [3.3,11]	
C30	245	B	Rm A10, on S wall [1.5,5], under center of air vent	
P252	301	-	W loading dock, on ramp's flat walkway (2.4 m (8 ft) wide), in middle of walkway (lengthwise); exterior	southernmost 7.6 m (25 ft) of ramp's W wall needs attention; southernmost 7.6 m (25 ft) of ramp's flat 2.4 m (8 ft) wide part sounds hollow and needs attention
P253	301	-	W loading dock, on E wall, about midway along the ramp, exterior	

Spec. No.	Bldg.	Level	Location	Remarks
P254	301	-	W loading dock, on S wall [.61,2], at W end near steel stairs; exterior	important to get samples from two different pours
P255	301	-	W loading dock, on W wall [.61,2], NW segment; exterior	
P256	301	-	W loading dock, on W wall [.61,2], in dumpster recess; exterior	
P257	301	-	W loading dock, on W wall, inside Door Leveler #1 on N wall [.46,1.5]; exterior	
P258	301	-	W loading dock, on W wall, below Dock Leveler #1 on outer wall [.15,.5]; exterior	
P259	301	-	W loading dock, on W wall [.15,.5], middle of wall (lengthwise); exterior	may be damage based on sounding
P260	301	-	W loading dock, on W wall [<1.2,4], inside dock leveler #2 (middle leveler) on horizontal surface; exterior	
P261	301	-	W loading dock, on W wall, inside dock leveler #2 (middle leveler) on S wall [<1.2,4]; exterior	
P262	301	-	W loading dock, on W wall, inside dock leveler #3 on N wall [<1.2,4]; exterior	

Spec. No.	Bldg.	Level	Location	Remarks
P263	301	-	W loading dock, on W wall, below dock leveler #3 on wall [.15,.5]; exterior	
P264	301	-	W loading dock, on W wall [.63,2.1] near S end; exterior	hollow sound immediately to N
P265	301	-	W loading dock, on W wall, inside dock leveler #4 on N wall [<1.2,4]; exterior	
P266	301	-	W loading dock, on W wall, below dock leveler #4 on wall [.15,.5]; exterior	
P267	301	-	W loading dock, on W wall, on S ramp, on wall [.31,1]; exterior	
C39	301	-	W loading dock, W wall of W loading ramp; exterior	southernmost 7.6 m (25 ft) of ramp's W wall needs attention; southernmost 7.6 m (25 ft) of ramp's flat 2.4 m (8 ft) wide part sounds hollow and needs attention
C40	301	-	W loading dock, on S wall midway near concrete spalling; exterior	some visible concrete distress on S wall all along the wall; soundings are mostly uniform on S wall (entire S wall sounded with hammer)

Spec. No.	Bldg.	Level	Location	Remarks
C41	301	-	W loading dock, on W wall [.46,1.5], about the middle of the wall (lengthwise); exterior	may be damage based on sounding
C42	301	-	W loading dock, on W wall [.56,1.8], a little S of the middle of the wall (lengthwise); exterior	hollow sound immediately to N
P271	302 Power Plant	lower level	on NW wall (.61-.91 m (2-3 ft))	
P272	302 Power Plant	lower level	on center wall [1.5,5]	
P273	302 Power Plant	lower level	underside of slab ceiling [2.0,6.5], condenser RU3 pad, in center	
P274	302 Power Plant	lower level	on center E wall [.08,.25]	
P311T	302 Power Plant	1F	near east end on north wall, several cm (inches) off ground; on exterior foundation wall	about 13 mm (1/2 in) from outside of concrete to edge of steel
P312T	302 Power Plant	1F	near door on east wall, several cm (inches) off ground; on exterior foundation wall	about 25 mm (1 in) from outside of concrete to edge of steel
P313	302 Power Plant	1F	SW corner,on exterior foundation wall, about .1 m (4 in) off ground	
P247	304	B	Rm. 11, on ceiling [4.3,14] near W wall, near cracks	concern that dust from sample collection may damage phone equipment

Spec. No.	Bldg.	Level	Location	Remarks
P248	304	B	Rm. 18, Telephone Room, on S wall [.31,1], at SW corner	concern that dust from sample collection may damage phone equipment
P249	304	B	Rm. 19, E wall [2.1,7]	concern that dust from sample collection may damage phone equipment
P169	310	-	on retaining wall [2.1,7], near Bldg. 307; exterior	
P268	cool-ing tower	-	on E side (across from transformer room), on vertical side of pad [.20,.7]; exterior	
P269	cool-ing tower	-	on horizontal pad, .31 m (1 ft) N of chain link fence in wet area; exterior	(dry area before sampling)
P275	cool-ing tower		on W wall [.20,.7]; exterior	rebar exposed, very thin cover
C43	cool-ing tower	-	on S wall [.31,1], about at center (lengthwise), wall is .61 m (2 ft) high; exterior	hollow sounding
C44	cool-ing tower	-	on horizontal pad on NW corner; exterior	
-	Nike Site	-	Pit # 1 inspected	.15 by 6.1 m (.5 by 20 ft) section (.93 sq m (10 sf)) on W wall needs to be patched - not a structural concern

Spec. No.	Bldg.	Level	Location	Remarks
-	Nike Site	-	Pit # 3 inspected	2.4 by 3.7 m (8 by 12 ft) bay ceiling on lower area damaged and needs to be repaired if personnel will occupy the area - DC hazard also exists and is a separate issue, which needs to be addressed.

Table 2a Site-Wide Inspection of Electric, Signal, and Telephone Manholes at NIST July to September 1991

Key and Notes - Metric

Entries for each element (wall, ceiling, access hole) are as follows from top to bottom: the percent severe delamination of each element is given as the first entry, the as-constructed area is the second entry (enclosed in parentheses) in square meters (SM), the area severely delaminated is the third entry (enclosed in brackets) in SM. Severe delamination was identified by a clear hollow sound upon tapping with hammer. In some cases, a chloride powder sample, denoted by "P" and followed by the manhole number and type, is given as the fourth entry. In a few cases, a partial-depth core, designated by a "C" followed by the manhole number and type is given as a fifth entry.

MH = manhole number.
N, S, E, and W = north, south, east, and west walls.
SG, TE, and EL = signal, telephone, and electric manhholes.
Cel, Acc Hole = ceiling, access hole.

Sum % = summation of percent severe delamination for the six elements: the four walls, the ceiling, and the access hole with a maximum entry of 600%, i.e., maximum of 100 % delaminated in each of the four walls, the ceiling, and the access hole.

Sum SM = summation of area (SM) of severely delaminated concrete on the six elements: the four walls, the ceiling, and the access hole.

DC = delaminated concrete; Y = delaminated concrete exists; number entry under "Y" is height in m of highest delaminated concrete; ck = check to see height of delaminated concrete above floor or to see if delaminated concrete exists.

ad = almost (very likely) delaminated, based on sounding.

Rust stains = inadequate (thin) concrete cover; note that in many of the manholes, rusted rebar ends protruded from the ceiling, with longitudinal axes of rebars normal to plane of ceiling.

Blockout = area on wall containing a pattern of holes through wall for passage of wires and conduit.

Note: Percentages of delamination based on walls with their blockout area included; delamination occurring on blockouts usually not included in percentage of delamination on wall.

Note: Assumed 0.77 SM for area of each of the 4 walls of the access holes or a total of 3.1 SM for all 4 walls of access hole - actual area varied somewhat from manhole to manhole.

Note: Electric manholes have asbestos encasing the 13,200 Volt lines (based on one sample from each of two manholes).

Note: Depth measured from bottom of access hole to floor of manhole.

Note: Unless noted otherwise, all dimensions are in meters (m).

Table 2

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM]								DC
	N	S	E	W	Cel	Acc Hole	Sum %	Sum SM	
5A EL	8 (2.2) [.18]						8	.18	Y ck
	Dimensions:2.4 deep x 3.7 x 1.8 with .91 wide x 2.4 deep NW diagonal wall; .18 sm severe delamination shown is on .91 wide x 2.4 deep northwest diagonal wall; honeycombing, cold joint on access hole								
5B EL		21 (8.9) [1.9] P5BEMH C5BEMH	3 (5.9) [.18]	20 (4.1) [.84]	2 (8.1) [.18]		64	4.7	Y 2
	Dimensions: 2.4 deep x 3.7 x 1.7 with .91 wide x 2.4 deep NW diagonal wall; in addition, 30% of S wall was "ad"; about half of S wall is probably delaminated; in addition, .18 sm of E wall was "ad"; in addition, .09 sm of ceiling was "ad"; rust stains on ceiling; cracking, rust stains at bottom of W wall of access hole; honeycomb and cold joint present in access hole; minor cracking present on diagonal wall; "ad" counted only as 1/2 in computing Sums (see text).								
7 TE	Dimensions: 1.1 deep x 1.2 x 1.2								
13 EL			50 (7.4) [3.7] P13SMH	20 (8.1) [1.6]	9 (3.1) [.28]		79	5.6	Y 2
	Dimensions: 2.4 deep; verify dimensions of W wall as either 2.4 x 3.7 or 2.4 x 2.4; average wall areas of 7.4 sm [(8.9+5.9)/2] used.								

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
13 SG	76 13 9 97 (3.9)(2.1)(3.1) [3.0][.28] [.28] 3.53	Y 2
	Dimensions: 2.1 deep; ceiling needs to be sounded; 13% on ceiling based on distress at bottom of access hole; verify dimensions of W wall as either 2.1x2.4 or 1.2x2.4; average wall area of 3.9 sm [(5.2+2.6)/2 used].	
13 TE	90 6 96 (2.1) (3.1) [1.9] [.18] 2.1 P13TMH C13TMH	Y 2
	Verify if crack/delamination at bottom of access hole	
14 SG	2 2 (3.3) [.07] .07 P14SMH	Y 2
	Only 1/2 walls sounded, no delamination found; ceiling needs to be sounded; 2 % on access hole based on distress at bottom of E wall of access hole; exposed rebar (about 25 mm of cover) on E wall of access hole at bottom; deterioration on all four bottom edges of access hole.	
16 SG	25 25 20 20 30 9 129 (2.1)(3.1) * * * * [.65][.28] 4.5*	Y 2
	*Assuming 2 walls to be 2.6 sm each, 2 walls to be 5.2 sm each, and an average percent delamination of 22.5% for all 4 walls, results in a total delamination of 3.5 sm for the 4 walls; then adding on the .93 sm for the ceiling and access hole, results in a "SUM SM" value of 4.5 sm. Dimensions of walls need to be determined.	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
16 TE	75 50 15 40 50 9 239 (2.1)(3.1) * * * * [1.1][.28] 7.5 to 9.3* P16TMHa P16TMHb C16TMH --- *Assuming 2 walls to be 2.6 sm each, 2 walls to be 5.2 sm each, and an average percent delamination of 62.5% for one parallel set of 2 walls and 27.5 % for the other parallel set of 2 walls, results in a total delamination for the 4 walls to range between 6.1 to 7.9 sm; then adding on the 1.4 sm for the ceiling and access hole, results in a "SUM SM" value ranging from 7.5 to 9.3 sm; dimensions of walls need to be determined; 0.02 sm spalled concrete on S wall.	Y 2
19 SG	Dimensions:2.1 deep x 1.2 x 2.4; exposed rebar (.3 m long) on N wall of access hole; spalling on access hole Note: take P19SMH from access hole	
19 TE	Dimensions:2.1 deep x 1.2 x 2.4	
20 SG	Dimensions:2.1 deep x 1.2 x 2.4	
20 TE	Dimensions:2.1 deep x 1.2 x 2.4 Note: take P20TMH from a wall	
21 EL	.5 12 8 16 1 38 (8.9)(8.9)(5.9)(5.9)(8.1) [.05][1.0][.46][.93][.09] 2.6 --- Dimensions: 2.4 deep x 2.4 x 3.7; mud on E wall; visible severe delaminations were on W wall and blockout on W wall; all delaminations on walls were around blockouts; for ceiling delamination: 0.05 sm on N side and 0.05 sm on S side; exposed rebar (25 mm) on access hole.	Y 2

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
21 SG	29 32 61 (2.6) (2.6) [.74] [.84] 1.6 P21EMH C21EMH --- Dimensions:2.1 deep x 1.2 x 2.4; 32 % delamination on W wall corresponds to .84 sm (two locations: .46 sm on bottom and .37 more sm); shear cracks on E wall; mud on W wall; mud on west part of ceiling; honeycomb, cold joint, exposed rebar (25 mm long) on access hole; all delaminations on walls were around blockouts	Y 2
21 TE	32 21 53 (2.6) (2.6) [.84] [.56] 1.4 --- Dimensions:2.1 deep x 1.2 x 2.4; blockout on W wall is severely delaminated; access hole has minor honeycomb and a cold joint; delaminations on walls were around blockouts	Y 1
25 EL	5 15 20 (5.9) (5.9) [.28] [.93] 1.2 --- Dimensions:2.4 deep x 2.4 x 3.7; minor spalling on W wall	Y 1 ck
25 SG	30 30 (2.6) [.74] .74 --- Dimensions: 2.1 deep x 1.2 x 2.4; cracking on bottom of N wall	
25 TE	15 40 55 (2.6) (2.6) [.37] [1.0] 1.4 P25TMH --- Dimensions: 2.1 deep x 1.2 x 2.4; patch on blockout severely delaminated	Y ck

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
29 EL	20 30 10 60 (8.1) [.84] 4.5 --- 4.5 sm total delaminated area estimated by assuming 25% delaminated for each of the S and W walls - area of 2 walls (estimated at 14.9 sm) needs to be determined; manhole is 2.4 m deep.	Y 2
29 SG	25 40 13 9 87 (2.1)(3.1) [.28][.28] 3.9 to 7.3 P29SMH C29SMH --- 3.9 to 7.3 sm delaminated based on either the 2 walls being 10.4 sm or 5.2 sm each in area - wall areas need to be determined; manhole is 2.1 m deep	Y 2
29 TE	25 25 [.65 to 1.3] .65 to 1.3 --- .65 to 1.3 sm delaminated based on either the wall being 5.2 sm or 2.6 sm in area - wall area needs to be determined; manhole is 2.1 m deep	
30 EL	1 1 (8.1) [.05] .05 --- Dimensions:2.4 deep x 2.4 x 3.6; Delamination and vertical and shear cracks (5) on N wall; 1 vertical and 2 horizontal cracks on S wall; exposed rebar on blockout of E and W walls; N wall could not be sounded due to asbestos-coated pipe lines in the way; cracking, delamination, exposed rebar on ceiling near (check) E wall of access hole; rust stains and cracking at bottom of access hole. This manhole was hotter than others and may have been raised .25 m	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
30 SG	10 20 1 16 (2.6) (2.1)(3.3) [.28] [.46][.02] .37 ad ad ad P30SMH --- Dimensions: 2.1 deep x 1.2 x 2.4; hairline cracking on blockouts on S wall; delamination on blockout on E wall; hairline crack at 30 deg with vertical and exposed rebar on W wall; rust stains, cold joint , horizontal hairline cracking on walls of access hole; "ad" counted only as 1/2 in computing Sums(see text)	Y 2 ck
30 TE	4 4 (2.1) [.09] .09 --- Dimensions: 2.1 deep x 1.2 x 2.4; vertical and shear cracks on N wall; vertical and horizontal hairline cracks on S wall; rust stains, hairline cracks, delamination on N and W walls of access hole; exposed rebar on N wall of access hole.	Y 2
31 EL	22 22 (5.9) [1.3] 1.3 --- Dimensions:2.4 deep x 2.4 x 3.7; visible delamination on N wall; 22% severe delamination on N wall corresponds to one .61 x .91 section and one .61 x 1.2 section; rust stains on access hole	Y 2
31 SG	1 39 40 (5.2) (2.1) [.05] [.84] .93 P31SMH --- Dimensions:2.1 deep x 1.2 x 2.4; 39% severe delamination on ceiling based on .46 sm on N side and .37 sm on the S side; 1 % severe delamination on E wall corresponds to .05 sm at .61 m from bottom of wall; rust stains and exposed rebars on access hole	Y 2

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
31 TE	7 (2.1) [.14] 7 .18 --- Dimensions:2.1 deep x 1.2 x 2.4; 7% severe delamination on ceiling corresponds to .09 sm in NW corner and .05 sm in SW corner; Vertical hairline crack on W wall; rust stains on ceiling	Y 2
33 EL	1 .3 1 (8.9) (3.1) [.09] [.01] .09 --- Dimensions: 2.4 deep x 2.4 x 3.7; top portion of blockout delaminated on W wall; minor crack on N wall of access hole	Y ck
33 SG	25 5 18 (5.2) (3.1) [1.3] [.18] .84 ad P33SMH --- Dimensions: 2.1 deep x 1.2 x 2.4; "ad" counted only as 1/2 in computing Sums (see text); cracks on N and W walls of access hole; exposed rebar on access hole; minor crack on W wall	Y 2
33 TE	Dimensions: 2.1 deep x 1.2 x 2.4; minor cracking at bottom of access hole.	
35 EL	Dimensions: 2.4 deep x 2.4 x 3.7	
35 SG	Dimensions: 2.1 deep x 1.2 x 2.4	
35 TE	Dimensions: 2.1 deep x 1.2 x 2.4 Note: take P35TMH and C35TMH from ceiling	
36 EL	Dimensions: 2.4 deep x 2.4 x 3.7; manhole raised (original height of access hole was 0.76 m; additional height of access hole was 0.76 m); 50 mm mud on bottom; no electric lines in manhole Note: take P36EMH from one wall	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
36 SG	Dimensions: 2.1 deep x 1.2 x 2.4; minor honeycombing on E wall; manhole raised (additional height of access hole was 1.3 m)	
36 TE	Not inspected, except observed a large masonry overhang at top of access hole which needs to be removed and hole filled to prevent a falling masonry hazard; Al Fox (Plant Division) said piece was removed and hole repaired (9/15/91)	
38 EL	3 3 (8.9) [.28] .28 P38EMH --- Dimensions: 2.4 deep x 2.4 x 3.7; blockout has some delamination on E wall	Y ck
38 SG	3 3 (3.1) [.09] .09 --- Dimensions: 2.1 deep x 1.2 x 2.4; exposed rebar, visible crack, spalling, severe delamination (.09 sm) on N and W walls of access hole.	Y 2
38 TE	Dimensions: 2.1 deep x 1.2 x 2.4; exposed rebar (about .20 m) on E wall	
40 EL	Dimensions: 2.4 deep x 2.4 x 3.7; exposed rebar, spalling on E wall of access hole	
40 SG	.5 .4 1 (2.1)(3.1) [.01][.01] 0 P40SMH --- Dimensions: 2.1 deep x 1.2 x 2.4; visible spalling, exposed rebar, and delamination (0.01 sm) on W wall of access hole; exposed rebar on blockout; exposed rebar on ceiling	Y 2
40 TE	Dimensions: 2.1 deep x 1.2 x 2.4; exposed rebar on E wall of access hole	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
42 EL	Dimensions: 2.4 deep x 2.4 x 3.7; rust stains on the access hole; exposed rebar on north wall	
42 SG	2 2 (3.1) [.05] .09 P42SMH --- Dimensions: 2.1 deep x 1.2 x 2.4; exposed rebar on access hole; delaminations on blockout; rust stains on ceiling	ck
42 TE	10 5 (3.1) [.28] .18 ad --- Dimensions: 2.1 deep x 1.2 x 2.4; rust stains on ceiling; visible delaminations and rust stains on access hole; manhole looked newer than some of others inspected; "ad" counted only as 1/2 in computing Sums (see text)	Y ck
44 EL	20 50 30 15 75 10 163 (5.9)(5.9)(8.9)(8.9)(8.1)(3.1) [1.2][3.0][2.7][1.3][6.0][.28] 11.7 ad ad ad ad P44EMH C44EMH --- Dimensions: 2.4 deep x 2.4 x 3.7; ceiling also had an additional 25% [2.0 sm] "ad" and access hole also had an additional 15% [.46 sm] "ad"; ceiling had visible delaminations, cracks, and rust stains; ceiling in very poor shape; minor spalling on W wall; exposed rebar on E wall of access hole; rust stains on access hole; "ad" counted only as 1/2 in computing Sums (see text)	Y 2

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
44 SG	20 30 20 30 50 3 113 (2.6) (2.6) (5.2) (5.2) (2.1) (3.1) [.56] [.74] [1.0] [1.6] [1.1] [.09] 3.5 ad ad ad --- Dimensions: 2.1 deep x 1.2 x 2.4; severe delamination: .10 by .90 m on N wall of access hole at bottom; minor crack and rust stain on N wall of access hole; "ad" counted only as 1/2 in computing Sums (see text)	Y 2
44 TE	70 70 (2.1) [1.5] 1.5 --- Dimensions: 2.1 deep x 1.2 x 2.4	Y 2
45 EL	3 16 (3.1) [.09] .46 --- Dimensions: 2.4 deep x 2.4 x 3.7; in addition to the .09 sm of severe delamination, the access hole had an additional 25 % "ad" and had rust stains and minor cracking; "ad" counted only as 1/2 in computing Sums (see text)	Y 2
45 SG	25 15 28 (5.2) (3.1) [1.3] [.46] 1.1 ad P45SMH --- Dimensions: 2.1 deep x 1.2 x 2.4; access hole has cracking and rust stains; manhole looked newer than some inspected; "ad" counted only as 1/2 in computing Sums (see text)	Y 2
45 TE	Dimensions: 2.1 deep x 1.2 x 2.4; manhole looked newer than some inspected; rust stains on access hole	
49 EL	Dimensions: 2.4 deep x 2.4 x 3.7	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
49 SG	11 (5.2) [.56] P49SMH 11 .56	Y ck
	Dimensions: 2.1 deep x 1.2 x 2.4; delamination and spalling visible on W wall; exposed rebar on N wall 40 mm long; exposed rebar on access hole	
49 TE	Dimensions: 2.1 deep x 1.2 x 2.4; access hole appears to have been raised .15 m; severe honeycombing on upper .15 m of access hole and is source of delaminated debris	Y 3
50 EL	16 (6.0) [.93] P50EMHa 16 (8.1) [1.3] P50EMHb C50EMH 32 2.2	Y 2
	Dimensions: 2.4 deep x 2.4 x 3.7; delamination is visible on S wall; severe delamination, spalling, honeycomb, heavy corrosion on rebar on ceiling; severe delamination extending completely across bottom of N and S walls of access hole, also exposed corroded rebar, spalling on N and S walls of access hole. Deterioration in ceiling may be of structural concern.	
50 EL	Shallow dimensions: 1.1 deep x .91 x .91	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
50 SG	4 11 4 26 6 67 (2.6) (2.6) (5.2) (2.1) (3.1) [.09] [.28] [.18] [.56] [.18] 2.0 ad --- Dimensions:2.1 deep x 1.2 x 2.4; cracks on N wall; in addition to the 11% severe delamination on the S wall, there was 14% [.37 sm] "ad" on S wall; also delaminated blockout on S wall; in addition to the 4% severe delamination on W wall there was 21% [1.1 sm] "ad" on the W wall; also exposed corroded rebar, hairline shear cracks, spalling, delamination on W wall; severe dealmination and spalling on ceiling; .18 sm (6%) of severe delamination was on one wall of access hole; "ad" counted only as 1/2 in computing Sums (see text) Deterioration in ceiling may be of structural concern.	Y 2
50 TE	5 13 16 (5.2) (2.1) [.28] [.28] .46 ad --- Dimensions:2.1 deep x 1.2 x 2.4; 13% severe delamination on ceiling corresponds to .18 sm on N side and .09 sm on the S side; .28 sm on E wall is on SE part; collapsed blockout, which may be a structural concern, in N wall with .06 cu m of mud in NW corner on floor; cracking at blockout at an angle on E wall, delamination, spalling, and cracking on E wall; exposed corroded rebar at bottom of E wall; severe delamination and spalling on the ceiling; delamination at bottom of access hole. "ad" counted only as 1/2 in computing Sums (see text); Deterioration in ceiling may be of structural concern.	Y 2
51 SG	Dimensions:2.1 deep x 1.2 x 2.4; exposed rebar (50mm long) on bottom of W wall of access hole	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
51 TE	1 1 2 (2.1) (3.1) [.02] [.04] .05 ad P51TMH --- Dimensions:2.1 deep x 1.2 x 2.4; delamination on blockout on N wall; delamination, exposed corroded rebar on blockout on S wall; delamination, spalled concrete, exposed corroded rebar on E wall of access hole; "ad" counted only as 1/2 in computing Sums (see text)	Y 2
53 EL	1 1 (8.1) [.05] .05 --- Dimensions: 2.4 deep x 2.4 x 3.7; exposed rebar on ceiling; efflorescence on W wall	Y 2
53 EL	Shallow dimensions: 1.2 deep x .91 x .91	
53 SG	4 4 (2.1) [.09] .09 --- Dimensions: 2.1 deep x 1.2 x 2.4; rust and minor honeycomb on ceiling	Y 2
53 TE	40 4 44 (2.6) (2.1) [1.0] [.09] 1.1 P53TMH C53TMH --- Dimensions: 2.1 deep x 1.2 x 2.4; exposed rebar on access hole	Y 2

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
62 EL	2 2 (6.0) [.09] .09 --- Dimensions: 2.4 deep x 2.4 x 3.7; cracking at bottom of E wall; minor cracking on S wall; E wall of access hole patched and cracked; N wall of access hole patched	
62 SG	5 11 3 19 (2.6)(2.6) (2.1) [.14][.28] [.07] .46 P62SMH --- Dimensions: 2.1 deep x 1.2 x 2.4; spalling at blockout on N wall; rust stains at ceiling on E wall; severe crack and spall, severely corroded rebar, patched, on N wall of access hole, not of immediate structural concern	Y 1
62 TE	7 7 (2.6) [.19] .19 --- Dimensions: 2.1 deep x 1.2 x 2.4; blockout delaminated on N wall; crack on S wall.	Y 1
64 EL	16 2 1 19 (6.0)(6.0) (8.1) [.93][.14] [.05] 1.1 --- Dimensions: 2.4 deep x 2.4 x 3.7; .5% severe delamination on ceiling corresponds to less than .05 sm; exposed rebar (.46 m long) due to honeycombing, visible delamination, and efflorescence on 3 sides on ceiling; cold joint on access hole	Y 2

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
64 SG	32 32 (2.6) [.84] .84 P64SMH --- Dimensions: 2.1 deep x 1.2 x 2.4; honeycombing, visible delamination, effloresence on N wall; honeycombing on ceiling; exposed rebar due to honeycombing (little rusting) on E wall of access hole.	Y ck
64 TE	23 2 25 (2.6) (2.1) [.60] [.05] .65 --- Dimensions: 2.1 deep x 1.2 x 2.4; honeycomb at top of N and S walls; efflorescence on E wall; honeycombing, exposed corroded rebar, delamination on access hole.	Y 2
67 EL	7 7 (1.3) [.09] .09 P67EMH --- Dimensions: 1.1 deep x 1.2 x 1.2; westernmost manhole; vertical cracking on the N and S walls; <u>cracking may be of structural concern</u>. Note: this manhole is being subjected to truck traffic and some of damage may be from mechanical loading.	ck
67 SG	Dimensions: 1.8 deep x 1.2 x 2.4; middle manhole; vertical and shear (45 deg) cracks on both N and S walls; <u>cracking may be of structural concern</u>; delamination on blockout on N wall; "bad" delamination on blockout on S wall; exposed rebar on bottom of N wall of access hole. Note: this manhole is being subjected to truck traffic and some of damage may be from mechanical loading.	
67 TE	Dimensions: 1.2 deep x 1.2 x 1.2, easternmost manhole; vertical cracking on N and S walls; <u>cracking may be of structural concern</u>. Note: this manhole is being subjected to truck traffic and some of damage may be from mechanical loading.	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SM) [Delaminated Area in SM] N S E W Cel Acc Hole Sum % Sum SM	DC
72 EL	2 (8.9) [.18] P72EMH 2 .18	ck
	Dimensions: 2.4 deep x 2.4 x 3.7; delamination on W wall may be a patch	
72 SG	Dimensions: 2.1 deep x 1.2 x 2.4; one of best manholes inspected; verify whether built at later date - looks newer than some others	
72 TE	Dimensions: 1.2 deep x 1.2 x 1.2; no access hole, ceiling was a steel top. Crack on W wall.	
80 SG	Dimensions: 2.1 deep x 1.2 x 2.4; exposed rebar on ceiling; exposed rebar and delamination on E wall of access hole, spalling, honeycomb, .61 m long on access hole (check for percent delamination on access hole) Note: take P19SMH from access hole	ck
80 TE	Shallow dimensions: 1.2 deep x 1.2 x 1.2	

Table 2b Site-Wide Inspection of Electric, Signal, and Telephone Manholes at NIST July to September 1991

Key and Notes - English Units

Entries for each element (wall, ceiling, access hole) are as follows from top to bottom: the percent severe delamination of each element is given as the first entry, the as-constructed area is the second entry (enclosed in parentheses) in square feet (SF), the area severely delaminated is the third entry (enclosed in brackets) in SF. Severe delamination was identified by a clear hollow sound upon tapping with hammer. In some cases, a chloride powder sample, denoted by "P" and followed by the manhole number and type, is given as the fourth entry. In a few cases, a partial-depth core, designated by a "C" followed by the manhole number and type is given as a fifth entry.

MH = manhole number.
N, S, E, and W = north, south, east, and west walls.
SG, TE, and EL = signal, telephone, and electric manhholes.
Cel, Acc Hole = ceiling, access hole.

Sum % = summation of percent severe delamination for the six elements: the four walls, the ceiling, and the access hole with a maximum entry of 600%, i.e., maximum of 100 % delaminated in each of the four walls, the ceiling, and the access hole.

Sum SF = summation of area (SF) of severely delaminated concrete on the six elements: the four walls, the ceiling, and the access hole.

DC = delaminated concrete; Y = delaminated concrete exists; number entry under "Y" is height in ft of highest delaminated concrete; ck = check to see height of delaminated concrete above floor or to see if delaminated concrete exists.

ad = almost (very likely) delaminated, based on sounding.

Rust stains = inadequate (thin) concrete cover; note that in many of the manholes, rusted rebar ends protruded from the ceiling, with longitudinal axes of rebars normal to plane of ceiling.

Blockout = area on wall containing a pattern of holes through wall for passage of wires and conduit.

Note: Percentages of delamination based on walls with their blockout area included; delamination occurring on blockouts usually not included in percentage of delamination on wall.

Note: Assumed 8.25 SF for area of each of the 4 walls of the access holes or a total of 33 SF for all 4 walls of access hole - actual area varied somewhat from manhole to manhole.

Note: Electric manholes have asbestos encasing the 13,200 Volt lines (based on one sample from each of two manholes).

Note: Depth measured from bottom of access hole to floor of manhole.

Table 2

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF] N S E W Cel Acc Hole Sum % Sum SF	DC
5A EL	8 8 (24) [2] 2 --- Dimensions:8′ deep x 12′ x 6′ with 3′wide x 8′deep NW diagonal wall; 2 sf severe delamination shown is on 3′wide x 8′ deep northwest diagonal wall; honeycombing, cold joint on access hole	Y ck
5B EL	21 3 20 2 64 (96) (64) (44) (87) [20] [2] [9] [2] 50 P5BEMH C5BEMH --- Dimensions: 8′ deep x 12′ x 5.5′ with 3′wide x 8′ deep NW diagonal wall; in addition, 30% of S wall was "ad"; about half of S wall is probably delaminated; in addition, 2 sf of E wall was "ad"; in addition, 1 sf of ceiling was "ad"; rust stains on ceiling; cracking, rust stains at bottom of W wall of access hole; honeycomb and cold joint present in access hole; minor cracking present on diagonal wall; "ad" counted only as 1/2 in computing Sums (see text).	Y 8
7 TE	Dimensions:3′-6" deep x4′x4′	
13 EL	50 20 9 79 (80) (87) (33) [40] [17] [3] 60 P13SMH --- Dimensions: 8′ deep; verify dimensions of W wall as either 8x12′ or 8x8′; average wall areas of 80 sf [(96+64)/2] used.	Y 8

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF]									DC
	N	S	E	W	Cel	Acc Hole		Sum %	Sum SF	
13 SG				76 (42) [32]	13 (23) [3]	9 (33) [3]		97	38	Y 7
	Dimensions: 7′ deep; ceiling needs to be sounded; 13% on ceiling based on distress at bottom of access hole; verify dimensions of W wall as either 7x8′ or 4x8′; average wall area of 42 sf [(56+28)/2 used].									
13 TE					90 (23) [21] P13TMH C13TMH	6 (33) [2]		96	23	Y 7
	Verify if crack/delamination at bottom of access hole									
14 SG						2 (36) [.75] P14SMH		2	.75	Y 7
	Only 1/2 walls sounded, no delamination found; ceiling needs to be sounded; 2 % on access hole based on distress at bottom of E wall of access hole; exposed rebar (about 1" of cover) on E wall of access hole at bottom; deterioration on all four bottom edges of access hole.									
16 SG	25 *	25 *	20 *	20 *	30 (23) [7]	9 (33) [3]		129	48•	Y 7
	•Assuming 2 walls to be 28 sf each, 2 walls to be 56 sf each, and an average percent delamination of 22.5% for all 4 walls, results in a total delamination of 37.8 sf for the 4 walls; then adding on the 10 sf for the ceiling and access hole, results in a "SUM SF" value of 48 sf. Dimensions of walls need to be determined.									

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF]	DC
	N S E W Cel Acc Hole Sum % Sum SF	
16 TE	75 50 15 40 50 9 239 (23) (33) * * * * [12] [3] 81 to 100* P16TMHa P16TMHb C16TMH --- *Assuming 2 walls to be 28 sf each, 2 walls to be 56 sf each, and an average percent delamination of 62.5% for one parallel set of 2 walls and 27.5 % for the other parallel set of 2 walls, results in a total delamination for the 4 walls to range between 66 to 85 sf; then adding on the 15 sf for the ceiling and access hole, results in a "SUM SF" value ranging from 81 to 100 sf; dimensions of walls need to be determined; 0.2 sf spalled concrete on S wall.	Y 7
19 SG	Dimensions:7′ deep x4′x8′; exposed rebar (1′ long) on N wall of access hole; spalling on access hole Note: take P19SMH from access hole	
19 TE	Dimensions:7′ deep x4′x8′	
20 SG	Dimensions:7′ deep x4′x8′	
20 TE	Dimensions:7′ deep x4′x8′ Note: take P20TMH from a wall	
21 EL	.5 12 8 16 1 38 (96) (96) (64) (64) (87) [.5] [11] [5] [10] [1] 28 --- Dimensions: 8′ deep x 8′x12′; mud on E wall; visible severe delaminations were on W wall and blockout on W wall; all delaminations on walls were around blockouts; for ceiling delamination: 1/2 sf on N side and 1/2 sf on S side; exposed rebar (1") on access hole.	Y 8

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF] N S E W Cel Acc Hole Sum % Sum SF	DC
21 SG	29 32 61 (28) (28) [8] [9] 17 P21EMH C21EMH --- Dimensions:7′ deep x4′x8′; 32 % delamination on W wall corresponds to 9 sf (two locations: 5 sf on bottom and 4 more sf); shear cracks on E wall; mud on W wall; mud on west part of ceiling; honeycomb, cold joint, exposed rebar (1" long) on access hole; all delaminations on walls were around blockouts	Y 5
21 TE	32 21 53 (28) (28) [9] [6] 15 --- Dimensions:7′ deep x4′x8′; blockout on W wall is severely delaminated; access hole has minor honeycomb and a cold joint; delaminations on walls were around blockouts	Y 4
25 EL	5 15 20 (64) (64) [3] [10] 13 --- Dimensions:8′ deep x8′x12′; minor spalling on W wall	Y 4 ck
25 SG	30 30 (28) [8] 8 --- Dimensions: 7′ deep x4′x8; cracking on bottom of N wall	
25 TE	15 40 55 (28) (28) [4] [11] 15 P25TMH --- Dimensions: 7′ deep x4′x8; patch on blockout severely delaminated	Y ck

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF]								DC
	N	S	E	W	Cel	Acc Hole	Sum %	Sum SF	
29 EL		20		30	10 (87) [9]		60	49	Y 8
	49 sf total delaminated area estimated by assuming 25% delaminated for each of the S and W walls - area of 2 walls (estimated at 160 sf) needs to be determined; manhole is 8 ft deep.								
29 SG	25	40			13 (23) [3]	9 (33) [3]	87	42 to 79	Y 7
	P29SMH C29SMH								
	42 to 79 sf delaminated based on either the 2 walls being 112 sf or 56 sf each in area - wall areas need to be determined; manhole is 7 ft deep								
29 TE		25					25		
	[7 to 14]							7 to 14	
	7 to 14 sf delaminated based on either the wall being 56 sf or 28 sf in area - wall area needs to be determined; manhole is 7 ft deep								
30 EL					1 (87) [.5]		1	.5	
	Dimensions:8' deep x8'x12'; Delamination and vertical and shear cracks (5) on N wall; 1 vertical and 2 horizontal cracks on S wall; exposed rebar on blockout of E and W walls; N wall could not be sounded due to asbestos-coated pipe lines in the way; cracking, delamination, exposed rebar on ceiling near (check) E wall of access hole; rust stains and cracking at bottom of access hole. This manhole was hotter than others and may have been raised 10 inches.								

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF] N S E W Cel Acc Hole Sum % Sum SF	DC
30 SG	10 20 1 16 (28) (23) (36) [3] [5] [.25] 4 ad ad ad P30SMH --- Dimensions: 7′ deep x4′x8′; hairline cracking on blockouts on S wall; delamination on blockout on E wall; hairline crack at 30 deg with vertical and exposed rebar on W wall; rust stains, cold joint , horizontal hairline cracking on walls of access hole; "ad" counted only as 1/2 in computing Sums(see text)	Y 8 ck
30 TE	4 4 (23) [1] 1 --- Dimensions: 7′ deep x 4′x 8′; vertical and shear cracks on N wall; vertical and horizontal hairline cracks on S wall; rust stains, hairline cracks, delamination on N and W walls of access hole; exposed rebar on N wall of access hole.	Y 8
31 EL	22 22 (64) [14] 14 --- Dimensions:8′ deep x8′x12′; visible delamination on N wall; 22% severe delamination on N wall corresponds to one 2′x3′ section and one 2′x4′section; rust stains on access hole	Y 6
31 SG	1 39 40 (56) (23) [.5] [9] 10 P31SMH --- Dimensions:7′ deep x4′x8′; 39% severe delamination on ceiling based on 5 sf on N side and 4 sf on the S side; 1 % severe delamination on E wall corresponds to 1/2 sf at 2′ from bottom of wall; rust stains and exposed rebars on access hole	Y 7

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF] N S E W Cel Acc Hole Sum % Sum SF	DC
31 TE	7 (23) [1.5] 7 2 --- Dimensions:7′ deep x4′x8′; 7% severe delamination on ceiling corresponds to 1 sf in NW corner and 1/2 sf in SW corner; Vertical hairline crack on W wall; rust stains on ceiling	Y 7
33 EL	1 (96) [1] .3 (33) [.1] 1 1 --- Dimensions: 8′ deep x 8′x 12′; top portion of blockout delaminated on W wall; minor crack on N wall of access hole	Y ck
33 SG	25 (56) [14] ad P33SMH 5 (33) [2] 18 9 --- Dimensions: 7′ deep x 4′x 8′; "ad" counted only as 1/2 in computing Sums (see text); cracks on N and W walls of access hole; exposed rebar on access hole; minor crack on W wall	Y 7
33 TE	Dimensions: 7′ deep x 4′x 8′; minor cracking at bottom of access hole.	
35 EL	Dimensions: 8′ deep x 8′x 12′	
35 SG	Dimensions: 7′ deep x 4′x 8′	
35 TE	Dimensions: 7′ deep x 4′x 8′ Note: take P35TMH and C35TMH from ceiling	
36 EL	Dimensions: 8′ deep x 8′x12′; manhole raised (original height of access hole was 2′-6"; additional height of access hole was 2′-6"); 2" mud on bottom; no electric lines in manhole Note: take P36EMH from one wall	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF] N S E W Cel Acc Hole Sum % Sum SF	DC
36 SG	Dimensions: 7′ deep x 4′x 8′; minor honeycombing on E wall; manhole raised (additional height of access hole was 4′-3")	
36 TE	Not inspected, except observed a large masonry overhang at top of access hole which needs to be removed and hole filled to prevent a falling masonry hazard; Al Fox (Plant Division) said piece was removed and hole repaired (9/15/91)	
38 EL	3 3 (96) 3 [3] P38EMH --- Dimensions: 8′ deep x 8′x 12′; blockout has some delamination on E wall	Y ck
38 SG	3 3 (33) [1] 1 --- Dimensions: 7′ deep x 4′x 8′; exposed rebar, visible crack, spalling, severe delamination (1 sf) on N and W walls of access hole.	Y 7
38 TE	Dimensions: 7′ deep x 4′x 8′; exposed rebar (about 2/3 ft) on E wall	
40 EL	Dimensions: 8′ deep x 8′x 12′; exposed rebar, spalling on E wall of access hole	
40 SG	.5 .4 1 (23) (33) [.1] [.1] 0 P40SMH --- Dimensions: 7′ deep x 4′x 8′; visible spalling, exposed rebar, and delamination (1/8 sf) on W wall of access hole; exposed rebar on blockout; exposed rebar on ceiling	Y 7
40 TE	Dimensions: 7′ deep x 4′x 8′; exposed rebar on E wall of access hole	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF] N S E W Cel Acc Hole Sum % Sum SF	DC
42 EL	Dimensions: 8′ deep x 8′x 12′; rust stains on the access hole; exposed rebar on north wall	
42 SG	2 2 (33) [.5] 1 P42SMH --- Dimensions: 7′ deep x 4′x 8′; exposed rebar on access hole; delaminations on blockout; rust stains on ceiling	ck
42 TE	10 5 (33) [3] 2 ad --- Dimensions: 7′ deep x 4′x 8′; rust stains on ceiling; visible delaminations and rust stains on access hole; manhole looked newer than some of others inspected; "ad" counted only as 1/2 in computing Sums (see text)	Y ck
44 EL	20 50 30 15 75 10 163 (64) (64) (96) (96) (87) (33) [13] [32] [29] [14] [65] [3] 126 ad ad ad ad P44EMH C44EMH --- Dimensions: 8′ deep x 8′x 12′; ceiling also had an additional 25% [22 sf] "ad" and access hole also had an additional 15% [5 sf] "ad" ; ceiling had visible delaminations, cracks, and rust stains; ceiling in very poor shape; minor spalling on W wall; exposed rebar on E wall of access hole; rust stains on access hole; "ad" counted only as 1/2 in computing Sums (see text)	Y 8

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF] N S E W Cel Acc Hole Sum % Sum SF	DC
44 SG	20 30 20 30 50 3. 113 (28) (28) (56) (56) (23) (33) [6] [8] [11] [17] [12] [1] 38 ad ad ad --- Dimensions: 7′ deep x 4′x 8′; severe delamination: 4" by 3′ on N wall of access hole at bottom; minor crack and rust stain on N wall of access hole; "ad" counted only as 1/2 in computing Sums (see text)	Y 7
44 TE	70 70 (23) [16] 16 --- Dimensions: 7′ deep x 4′x 8′	Y 7
45 EL	3 16 (33) [1] 5 --- Dimensions: 8′ deep x 8′x 12′; in addition to the 1 sf of severe delamination, the access hole had an additional 25 % "ad" and had rust stains and minor cracking; "ad" counted only as 1/2 in computing Sums (see text)	Y 8
45 SG	25 15 28 (56) (33) [14] [5] 12 ad P45SMH --- Dimensions: 7′ deep x 4′x 8′; access hole has cracking and rust stains; manhole looked newer than some inspected; "ad" counted only as 1/2 in computing Sums (see text)	Y 7
45 TE	Dimensions: 7′ deep x 4′x 8′; manhole looked newer than some inspected; rust stains on access hole	
49 EL	Dimensions: 8′ deep x 8′x 12′	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF] N S E W Cel Acc Hole Sum % Sum SF	DC
49 SG	11 (56) [6] P49SMH 11 6	Y ck
	Dimensions: 7′ deep x 4′x 8′; delamination and spalling visible on W wall; exposed rebar on N wall 1.5" long; exposed rebar on access hole	
49 TE	Dimensions: 7′ deep x 4′x 8′; access hole appears to have been raised 6"; severe honeycombing on upper 6" of access hole and is source of delaminated debris	Y 9
50 EL	16 (64) [10] P50EMHa 16 (87) [14] P50EMHb C50EMH 32 24	Y 8
	Dimensions: 8′ deep x 8′x 12′; delamination is visible on S wall; severe delamination, spalling, honeycomb, heavy corrosion on rebar on ceiling; severe delamination extending completely across bottom of N and S walls of access hole, also exposed corroded rebar, spalling on N and S walls of access hole. Deterioration in ceiling may be of structural concern.	
50 EL	Shallow dimensions: 3′-9" deep x 3′x 3′	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF]	DC
	N S E W Cel Acc Hole Sum % Sum SF	
50 SG	4 11 4 26 6 67 (28) (28) (56) (23) (33) [1] [3] [2] [6] [2] 22 ad	Y 7
	Dimensions:7′ deep x 4′x 8′; cracks on N wall; in addition to the 11% severe delamination on the S wall, there was 14% [4 sf] "ad" on S wall; also delaminated blockout on S wall; in addition to the 4% severe delamination on W wall there was 21% [12 sf] "ad" on the W wall; also exposed corroded rebar, hairline shear cracks, spalling, delamination on W wall; severe dealmination and spalling on ceiling; 2 sf (6%) of severe delamination was on one wall of access hole; "ad" counted only as 1/2 in computing Sums (see text) Deterioration in ceiling may be of structural concern.	
50 TE	5 13 16 (56) (23) [3] [3] 5 ad	Y 7
	Dimensions:7′ deep x 4′x 8′; 13% severe delamination on ceiling corresponds to 2 sf on N side and 1 sf on the S side; 3 sf on E wall is on SE part; collapsed blockout, which may be a structural concern, in N wall with 2 cu ft of mud in NW corner on floor; cracking at blockout at an angle on E wall, delamination, spalling, and cracking on E wall; exposed corroded rebar at bottom of E wall; severe delamination and spalling on the ceiling; delamination at bottom of access hole. "ad" counted only as 1/2 in computing Sums (see text); Deterioration in ceiling may be of structural concern.	
51 SG	Dimensions:7′ deep x 4′x 8′; exposed rebar (2" long) on bottom of W wall of access hole	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF] N S E W Cel Acc Hole Sum % Sum SF	DC
51 TE	1 1 2 (23) (33) [.2] [.4] .5 ad P51TMH --- Dimensions:7′ deep x 4′x 8′; delamination on blockout on N wall; delamination, exposed corroded rebar on blockout on S wall; delamination, spalled concrete, exposed corroded rebar on E wall of access hole; "ad" counted only as 1/2 in computing Sums (see text)	Y 7
53 EL	1 1 (87) [.5] .5 --- Dimensions: 8′ deep x 8′x 12′; exposed rebar on ceiling; efflorescence on W wall	Y 8
53 EL	Shallow dimensions: 4′ deep x 3′ x 3′	
53 SG	4 4 (23) [1] 1 --- Dimensions: 7′ deep x 4′x 8′; rust and minor honeycomb on ceiling	Y 7
53 TE	40 4 44 (28) (23) [11] [1] 12 P53TMH C53TMH --- Dimensions: 7′ deep x4′x8′; exposed rebar on access hole	Y 7
62 EL	2 2 (64) [1] 1 --- Dimensions: 8′ deep x 8′x 12′; cracking at bottom of E wall; minor cracking on S wall; E wall of access hole patched and cracked; N wall of access hole patched	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF] N S E W Cel Acc Hole Sum % Sum SF	DC
62 SG	5 11 3 19 (28) (28) (23) [1.5] [3] [.8] 5 P62SMH --- Dimensions: 7′ deep x 4′x 8′; spalling at blockout on N wall; rust stains at ceiling on E wall; severe crack and spall, severely corroded rebar, patched, on N wall of access hole, not of immediate structural concern	Y 4
62 TE	7 7 (28) [2] 2 --- Dimensions: 7′ deep x 4′x 8′; blockout delaminated on N wall; crack on S wall.	Y 4
64 EL	16 2 1 19 (64) (64) (87) [10] [1.5] [.5] 12 --- Dimensions: 8′ deep x 8′ x 12′; .5% severe delamination on ceiling corresponds to less than 1/2 sf; exposed rebar (18" long) due to honeycombing, visible delamination, and efflorescence on 3 sides on ceiling; cold joint on access hole	Y 8
64 SG	32 32 (28) [9] 9 P64SMH --- Dimensions: 7′ deep x 4′x 8′; honeycombing, visible delamination, effloresence on N wall; honeycombing on ceiling; exposed rebar due to honeycombing (little rusting) on E wall of access hole.	Y ck
64 TE	23 2 25 (28) (23) [6.5] [.5] 7 --- Dimensions: 7′ deep x 4′x 8′; honeycomb at top of N and S walls; efflorescence on E wall; honeycombing, exposed corroded rebar, delamination on access hole.	Y 7

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF] N S E W Cel Acc Hole Sum % Sum SF	DC
67 EL	7 (14) [1] P67EMH 7 1	ck
	Dimensions: 3'-7" deep x 4'x 4'; westernmost manhole; vertical cracking on the N and S walls; <u>cracking may be of structural concern</u>. Note: this manhole is being subjected to truck traffic and some of damage may be from mechanical loading.	
67 SG	Dimensions: 6' deep x 4' x 8'; middle manhole; vertical and shear (45 deg) cracks on both N and S walls; <u>cracking may be of structural concern</u>; delamination on blockout on N wall; "bad" delamination on blockout on S wall; exposed rebar on bottom of N wall of access hole. Note: this manhole is being subjected to truck traffic and some of damage may be from mechanical loading.	
67 TE	Dimensions: 4'deep x 4'x 4', easternmost manhole; vertical cracking on N and S walls; <u>cracking may be of structural concern</u>. Note: this manhole is being subjected to truck traffic and some of damage may be from mechanical loading.	
72 EL	2 (96) [2] P72EMH 2 2	ck
	Dimensions: 8' deep x8'x12'; delamination on W wall may be a patch	
72 SG	Dimensions: 7' deep x 4'x 8'; one of best manholes inspected; verify whether built at later date - looks newer than some others	
72 TE	Dimensions: 4' deep x 4'x 4'; no access hole, ceiling was a steel top. Crack on W wall.	

MH	Severe Delamination Percent Delamination (As-Constructed Area of Element in SF) [Delaminated Area in SF] N S E W Cel Acc Hole Sum % Sum SF	DC
80 SG	Dimensions: 7′ deep x 4′x 8′; exposed rebar on ceiling; exposed rebar and delamination on E wall of access hole, spalling, honeycomb, 2′ long on access hole (check for percent delamination on access hole) Note: take P19SMH from access hole	ck
80 TE	Shallow dimensions: 4′ deep x 4′ x 4′	

Table 3a Ranking of Electric, Signal, and Telephone Manholes Based on Concrete Delamination and Other Major Structural Distress

Key and Notes: Metric Units

Sum % = total percent severe delamination for the four walls, the ceiling, and the access hole with a maximum entry of 600%, i.e., 100 % delaminated in each of the four walls, the ceiling, and the access hole, from Table 2; average in brackets

Sum SM = total area (square meters) of severely delaminated concrete on the four walls, the ceiling, and the access hole, from Table 2a; average in brackets

MH = manhole number
N, S, E, and W = north, south, east, and west
SG, TE, and EL = signal, telephone, and electric manhholes

a, b, c denote equivalent rank. When ranking manholes, "Sum SM" was given more importance than "Sum %" (see text).

MH	Total Severe Delamination		Rank (#1 most severe)
	Percent (Sum %) [average]	Area (Sum SM) [average]	
67EL 67SG 67TE	7 0 0 [2]	.09 0 0 [0]	1
	cracking may be of structural concern. Note: these manholes are being subjected to truck traffic and some of damage may be from mechanical loading.		
16SG 16TE	129 239 [184]	4.5 7.5 to 9.3 [6.0 to 6.9]	2
44EL 44SG 44TE	163 113 70 [115]	11.7 3.5 1.5 [5.6]	3
13EL 13SG 13TE	79 97 96 [91]	5.6 3.5 2.1 [3.7]	4

MH	Total Severe Delamination Percent (Sum %) [average]	 Area (Sum SM) [average]	Rank (#1 most severe)
50EL 50SG 50TE	32 67 16 [38]	2.2 2.0 .46 [1.6]	5
	In 50EL,50SG, and 50 TE, deterioration in ceiling may be of structural concern.In 50TE, a collapsed blockout in N wall, may also be a structural concern. Note: there was a fourth manhole numbered 50P, which had dimensions of 1.1 deep x .91 x .91 m, and had no visible deterioration.		
29EL 29SG 29TE	60 87 25 [57]	4.5 3.3 to 6.8 .65 to 1.3 [2.9 to 4.2]	6
21EL 21SG 21TE	38 61 53 [51]	2.6 1.6 1.4 [1.9]	7
5AEL 5BEL	8 64 [36]	.19 4.7 [2.4]	8
25EL 25SG 25TE	20 30 55 [35]	1.2 .74 1.4 [1.1]	9
64EL 64SG 64TE	19 32 25 [25]	1.1 .84 .65 [.84]	10a
31EL 31SG 31TE	22 40 7 [23]	1.3 .93 .19 [.84]	10b
45EL 45SG 45TE	16 28 0 [15]	.46 1.1 0 [.56]	11a

MH	Total Severe Delamination Percent (Sum %) [average]	 Area (Sum SM) [average]	Rank (#1 most severe)
53EL 53SG 53TE	1 4 44 [16]	.05 .09 1.1 [.46]	11b
62EL 62SG 62TE	2 19 7 [9]	.09 .46 .19 [.28]	12
30EL 30SG 30TE	1 16 4 [7]	.05 .37 .09 [.19]	13
33EL 33SG 33TE	1 18 0 [6]	.09 .84 0 [.28]	14
49EL 49SG 49TE	0 11 0 [4]	0 .56 0 [.19]	15
38EL 38SG 38TE	3 3 0 [2]	.28 .09 0 [.09]	16a
42EL 42SG 42TE	0 2 5 [2]	0 .09 .19 [.09]	16b
14SG	2 [2] --- 14TE needs to be inspected	.07 [.07] ---	16c
51SG 51TE	0 2 [1]	0 .05 [0]	17
72EL 72SG 72TE	2 0 0 [1]	.19 0 0 [.09]	18

MH	Total Severe Delamination		Rank (#1 most severe)
	Percent (Sum %) [average]	Area (Sum SM) [average]	
40EL	0	0	19a
40SG	1	0	
40TE	0	0	
	[0]	[0]	
80SG	0	0	19b
80TE	0	0	
19SG	0	0	19c
19TE	0	0	
36EL	0	0	19d
36SG	0	0	
	36TE needs to be inspected		
7TE	0	0	20a
	7SG needs to be inspected		
20SG	0	0	20b
20TE	0	0	
35EL	0	0	20c
35SG	0	0	
35TE	0	0	

Table 3b Ranking of Electric, Signal, and Telephone Manholes Based on Concrete Delamination and Other Major Structural Distress

Key and Notes: English Units

Sum % = total percent severe delamination for the four walls, the ceiling, and the access hole with a maximum entry of 600%, i.e., 100 % delaminated in each of the four walls, the ceiling, and the access hole, from Table 2; average in brackets

Sum SF = total area (square feet) of severely delaminated concrete on the four walls, the ceiling, and the access hole, from Table 2b; average in brackets

MH = manhole number
N, S, E, and W = north, south, east, and west
SG, TE, and EL = signal, telephone, and electric manhholes

a, b, c denote equivalent rank. When ranking manholes, "Sum SF" was given more importance than "Sum %" (see text).

MH	Total Severe Delamination		Rank (#1 most severe)
	Percent (Sum %) [average]	Area (Sum SF) [average]	
67EL 67SG 67TE	7 0 0 [2]	1 0 0 [0]	1
	cracking may be of structural concern. Note: these manholes are being subjected to truck traffic and some of damage may be from mechanical loading.		
16SG 16TE	129 239 [184]	48 81 to 100 [65 to 74]	2
44EL 44SG 44TE	163 113 70 [115]	126 38 16 [60]	3
13EL 13SG 13TE	79 97 96 [91]	60 38 23 [40]	4

MH	Total Severe Delamination Percent (Sum %) [average]	 Area (Sum SF) [average]	Rank (#1 most severe)
50EL 50SG 50TE	32 67 16 [38]	24 22 5 [17]	5
	In 50EL,50SG, and 50 TE, deterioration in ceiling may be of structural concern.In 50TE, a collapsed blockout in N wall, may also be a structural concern. Note: there was a fourth manhole numbered 50P, which had dimensions of 3'-9" deep x 3' x 3', and had no visible deterioration.		
29EL 29SG 29TE	60 87 25 [57]	49 36 to 73 7 to 14 [31 to 45]	6
21EL 21SG 21TE	38 61 53 [51]	28 17 15 [20]	7
5AEL 5BEL	8 64 [36]	2 50 [26]	8
25EL 25SG 25TE	20 30 55 [35]	13 8 15 [12]	9
64EL 64SG 64TE	19 32 25 [25]	12 9 7 [9]	10a
31EL 31SG 31TE	22 40 7 [23]	14 10 2 [9]	10b
45EL 45SG 45TE	16 28 0 [15]	5 12 0 [6]	11a

MH	Total Severe Delamination Percent (Sum %) [average]	 Area (Sum SF) [average]	Rank (#1 most severe)
53EL 53SG 53TE	1 4 44 [16]	.5 1 12 [5]	11b
62EL 62SG 62TE	2 19 7 [9]	1 5 2 [3]	12
30EL 30SG 30TE	1 16 4 [7]	.5 4 1 [2]	13
33EL 33SG 33TE	1 18 0 [6]	1 9 0 [3]	14
49EL 49SG 49TE	0 11 0 [4]	0 6 0 [2]	15
38EL 38SG 38TE	3 3 0 [2]	3 1 0 [1]	16a
42EL 42SG 42TE	0 2 5 [2]	0 1 2 [1]	16b
14SG	2 [2] --- 14TE needs to be inspected	.75 [.75]	16c
51SG 51TE	0 2 [1]	0 .5 [0]	17
72EL 72SG 72TE	2 0 0 [1]	2 0 0 [1]	18

MH	Total Severe Delamination Percent (Sum %) [average]	 Area (Sum SF) [average]	Rank (#1 most severe)
40EL 40SG 40TE	0 1 0 [0]	0 0 0 [0]	19a
80SG 80TE	0 0	0 0	19b
19SG 19TE	0 0	0 0	19c
36EL 36SG	0 0 --- 36TE needs to be inspected	0 0	19d
7TE	0 --- 7SG needs to be inspected	0	20a
20SG 20TE	0 0	0 0	20b
35EL 35SG 35TE	0 0 0	0 0 0	20c

Table 4. Priority Ranking, Distressed Areas, Impact of Failure, Scope (Number of People Affected), and Estimated Costs of Testing

KEY

Impact = extent of damage if failure occurs:

under "Safety", degree of seriousness of a safety injury

under "Struct", degree of structural damage and corresponding need of further structural investigation

No. of People = number of people occupying structure
DC = potential for delaminated concrete falling (under "Safety")
T = tripping hazard (under "Safety")
OK = not a safety concern (under "Safety")
N,S,E,W = north, south, east, west (under "Distressed Areas")

H = high
M =medium
L = low

Criteria:

For Impact, Safety: High = could result in death of an occupant

Medium = tripping hazard, or could result in injury

For Impact, Structural: High = potential for total or partial collapse

Medium = potential for partial collapse or further deterioration

Low = potential for further deterioration

For Scope (number of occupants): High = structure normally occupied

Medium = structure occupied only some of the time

Low = structure occupied infrequently

Est Test Cost = cost of powder chloride and core samples based on costs listed in "KEY" in Table 5

Distressed areas are ranked as high (H), medium (M), or low (L). A high ranking indicates that the area is in urgent need of repair. A medium ranking means that the area should be repaired after the high ranking areas are repaired. A low ranking indicates that the area needs (i) to repaired after the high and medium rank repairs are made, or (ii) to be kept under surveillance and, if necessary, repaired. With all the rankings, further testing may be needed to determine the severity. Under the high rank (H), H-1 is the most important of high rank, H-2 is next most important, etc.; M-1 is the most important of medium rank, M-2 is next most important, etc.; and L-1 is the most important of low rank, L-2 is next most important, etc. Under this ranking scheme, the least important high ranking item (H-5) would be in more urgent need of repair than the most important medium ranking item (M-1).

Table 4

Rank	Bldg	Distressed Areas	Impact Safety	Impact Structural	No. of People	Est Test Cost ($K)
H-1a	233	severe cracking, delamination, and rebar corrosion on underside of roof slab in Room A 121; preliminary site inspection performed by D. McMullan and Assoc. on Dec.17, 1991	H; delaminated concrete removed	H	H	0.18
H-1b	245	southeast loading dock, A Wing, Rm. A120, crushed concrete at beam column connection; additional cracks in beams and columns; preliminary site inspection performed by D. McMullan and Assoc. on Dec.17, 1991	H; delaminated concrete removed	H	H or M	0.14
H-1c	231	Rm. A169 Sump, delamination, cracking, and spalling	DC,H	H	H	2.19
H-2	205	severe deterioration of stairs	T,M	L	H	.035
H-3	245	SW loading dock: needs to be replaced	T,M	L	H	.070
H-4	101	exterior stairs on N side near guard office, need replacement	T,M	L	H	.035

Rank	Bldg	Distressed Areas	Impact Safety	Structural	No. of People	Est Test Cost ($K)
H-5	206	2 or 3 westernmost bins:				
		on ground level	DC,H	H	M	1.32
		on upper level	H; delaminated concrete removed in 2nd bin from W end	H	L	.845
		Preliminary site inspection performed by D. McMullan and Assoc. on Dec.17, 1991				
H-6a	-	Replacement of steam manholes; need to determine the structural adequacy and the number requiring repair or replacement for about 30 remaining steam manholes	DC,H	H	L	20.1 for 30 man-hole
H-6b	-	severe delamination in electric, signal, and telephone manholes; need to determine the structural adequacy and the number requiring repair or replacement of 175 total; need to investigate remaining 97 manholes	DC,H	H	L	7.65

Rank	Bldg	Distressed Areas	Impact Safety	Impact Structural	No. of People	Est Test Cost ($K)
M-1	235	Rm. C006 on N wall; wall appears to be bubbled out, possibly delaminated; could not get close enough to confirm. This is a high radiation area; should be inspected when safe to do so	need to verify H; Note: a structural failure could have very serious consequences	H	L, but could affect many people	-
M-2	245	construction joint, 3.1 m (10 ft) S of Rm B041 on bottom of northernmost beam, substantial distress	DC,H	H	H	0.34
M-3	230	fresh air intake pit on NW corner of 230 off Rm. C04, several areas of severe delamination, steel door also needs replacement. Preliminary site inspection performed by D. McMullan and Assoc. on Dec.17, 1991	H; most delaminated concrete removed; need to check for delaminated concrete on underside of overhead beams	H	L	0.78
M-4	245	Rm. A008 has badly delaminated walls and beam sides and bottom	DC,H	M	M	0.78

Rank	Bldg	Distressed Areas	Impact Safety	Structural	No. of People	Est Test Cost ($K)
M-5	231	W stairwell, entrance to mechanical room, delamination on exterior ceiling	delaminated concrete removed	M	M	0.44
M-6a	222	northernmost portion telephone closet, Rm. A 01, on beam bottom and other overhead areas	DC,H some delaminated concrete removed	M	L	0.34
M-6b	226	Transformer Room, northernmost portion Rm. B03, visual overhead delaminations (e.g,beam)	delaminated concrete removed	M	L	0.60
M-7	231	Rm. A169	DC,H Note: verify delaminated concrete	M	H	0.21
M-8	301	W loading dock, southernmost 7.6 m (25 ft) of ramp's W wall needs attention; southernmost 7.6 m (25 ft) of ramp's flat 2.4 m (8 ft) wide part sounds hollow and needs attention	OK	L	H	0.30
M-9	235	Rm. D01 Pump Room, delamination on ceiling; need to investigate the cause of damage	delaminated concrete removed	M	M	0.53

Rank	Bldg	Distressed Areas	Impact Safety	Impact Structural	No. of People	Est Test Cost ($K)
M-10a	230	fresh air pit just S of the NW pit (adjoins NW pit), delaminations	DC,M	L	L	0.30
M-10b	101	fresh air pits on S side of library	DC,M	L	L	0.60
L-1	245	NE loading dock: distressed, needs further evaluation	OK	M	H	1.34
L-2	301	W loading dock, a number of areas need further evaluation	OK	L	H	1.32
L-3	220	mechanical room, on N wall, construction joint needs repair	OK	L	L	0.11
L-4a	302	possible problem with corrosion of rebar in exterior foundation walls	OK	M	H	0.11
L-4b	245	possible problem with corrosion of rebar in exterior foundation walls	OK	M	H	0.04
L-4c	235	possible problem with corrosion of rebar in exterior foundation walls	OK	M	H	0.04
L-5	245	Rm. A10, needs further evaluation	OK	M	M	0.51

Rank	Bldg	Distressed Areas	Impact Safety	Impact Structural	No. of People	Est Test Cost ($K)
L-6	245	Rm. A 007, needs further evaluation	DC (check)	M	M	0.11
L-7	225	concourse between 225 and library, visible distress on W wall	OK	M	H	0.62
L-8	101	exterior columns outside of Health Unit, verify whether steel shapes or reinforced concrete	DC,H	M	H	
L-9	236	N side of 236, exterior, delaminations on vertical face and horizontal underside of parapet wall	DC,H	M	L	0.37
L-10	220	Rm. C09, Transformer Room, diagonal crack at beam column and also a vertical crack on column at end of beam - cracks should be periodically evaluated; verify if delaminated concrete present	DC (check)	M	L	0.11
L-11	206	parapet wall, visible from second floor, rebar exposed	OK	L	L	0.07

Rank	Bldg	Distressed Areas	Impact Safety	Impact Structural	No. of People	Est Test Cost ($K)
L-12	101	library, W end of S wall under overhang	delaminated concrete removed	L	L	0.04
L-13	245	Rm. A100, Central region (with respect to E-W), on slab bottom, "visually deteriorated"	appears to be heavy coat of paint peeling off(check)	L	L	0.18
L-14	221	Service Entry Rm,hollow sound in NW corner on W wall, 0.61 to 0.91 m (2 to 3 ft) off floor, no visual distress	OK	L	L	0.37

Table 5. Summary of Number of Powder and Core Samples and Estimated Testing Costs

KEY: Inside,Outside = samples to be taken inside or outside (exterior exposure) of building

EL, SG, TE (78) = electric, signal, and telephone manholes; includes all 78 manholes investigated

EL, SG, TE (97) = electric, signal, and telephone manholes; includes 97 manholes remaining to be investigated

st'm mhs (30) = about 30 steam manholes remaining to be investigated

Estimates of Testing Costs:

Powder chloride = $35/powder sample

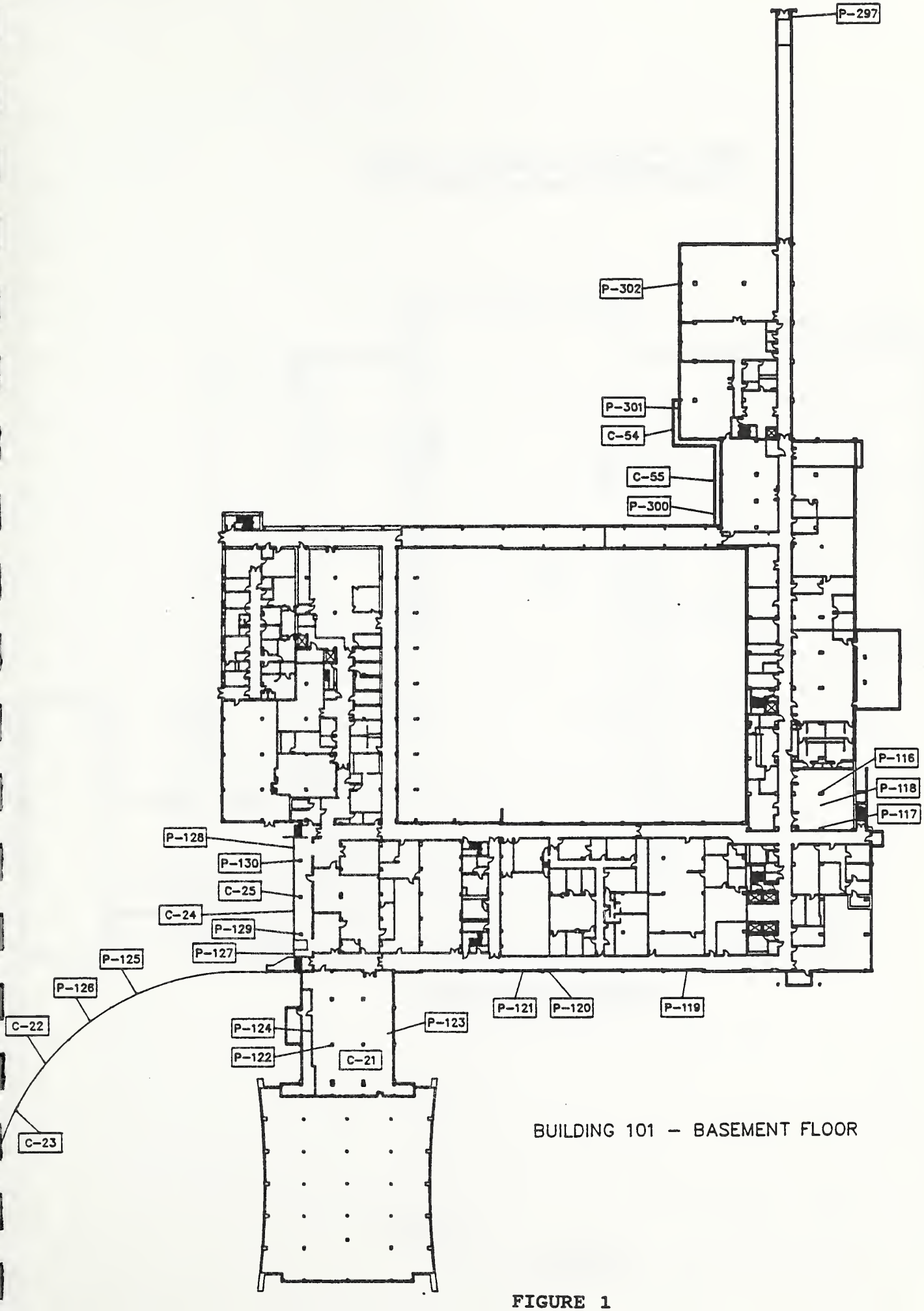
Core = $265/core (coring + repair,150; inspection of core deterioration + writeup, 50; total chloride ion from one end of core [pulverizing + testing], 35; carbonation depth, includes splitting in lab, 30;)

Bldg	No. Powder Chloride			No. Cores			Total Testing Costs $K
	Inside	Outside	Total	Inside	Outside	Total	
101	10	10	20	1	6	7	2.555
202	1	2	3		1	1	0.370
205		1	1			0	0.985
206	29	4	33	5		5	2.480
224	21	2	23	1		1	1.070
224	12		12	2		2	0.950
222	13		13	2		2	0.985
223	12		12	1		1	0.685
224	18	2	20	2		2	1.230
225	10	12	22	1	1	2	1.300
226	8	1	9	2		2	0.845
230	5	15	20		5	5	2.025
231	24	9	33	7		7	3.010
233	9	4	13			0	0.455

Bldg	No. Powder Chloride			No. Cores			Total Testing Costs $K
	Inside	Outside	Total	Inside	Outside	Total	
235		1	1	8		8	2.155
236	4	6	10		1	1	0.615
245	45	13	58	5	5	10	4.680
301		16	16		4	4	1.620
302	4	3	7			0	0.245
304	3		3			0	0.105
310		1	1			0	0.035
cool -ing towr		3	3		2	2	0.635
EL, SG, TE (78)	30		30	9		9	3.435
EL, SG, TE (97)	37		37	11		11	4.210
st'm mhs (30)	120		120	60		60	20.100
TOTL	415	105	520	117	25	142	55.830

FIGURES 1 TO 99

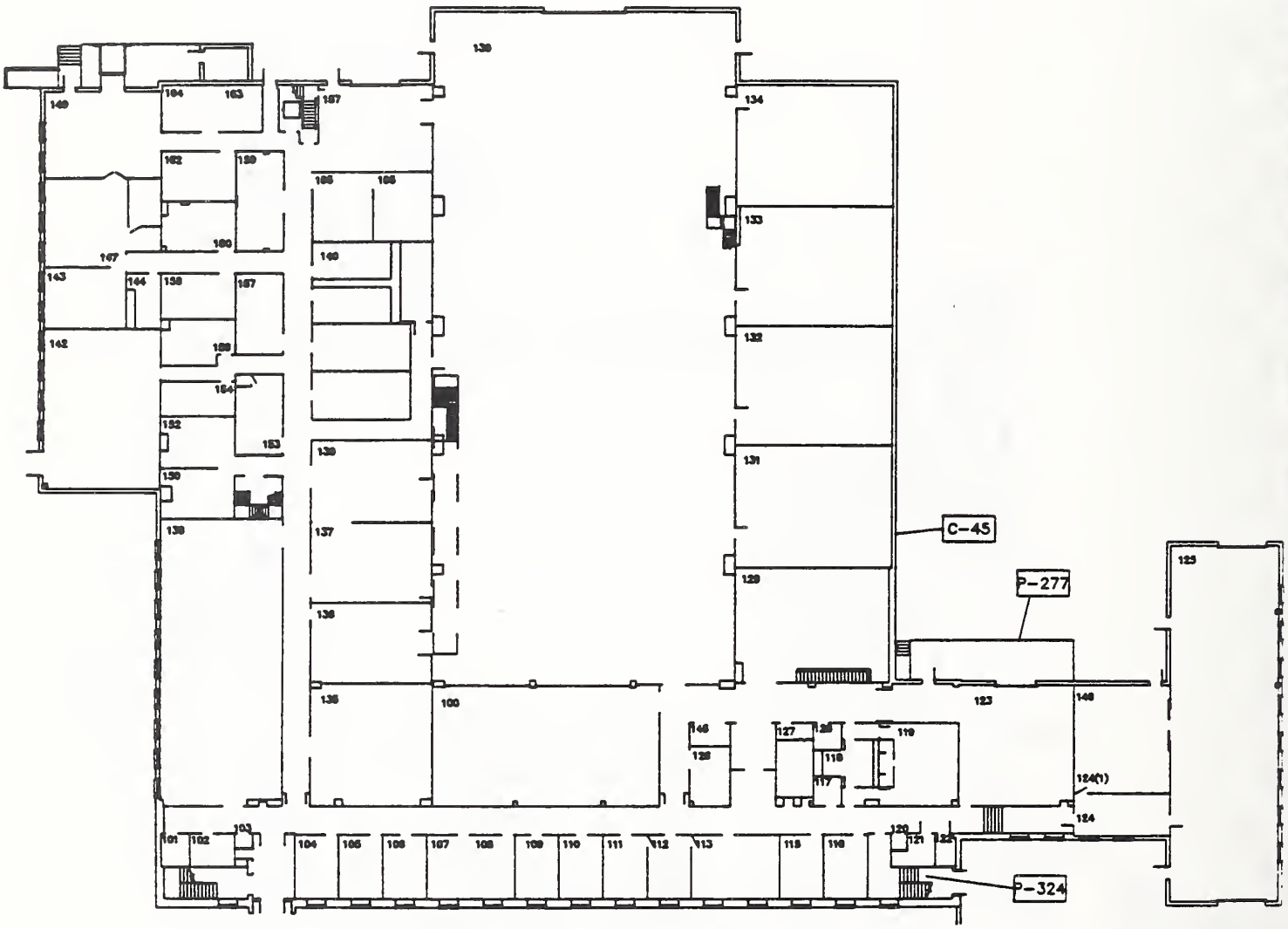
Figures 1 to 47: Locations of Almost All Chloride Powder and Core Samples for Buildings and Related Structures (A complete listing of all samples is given in Table 1)



BUILDING 101 – BASEMENT FLOOR

FIGURE 1

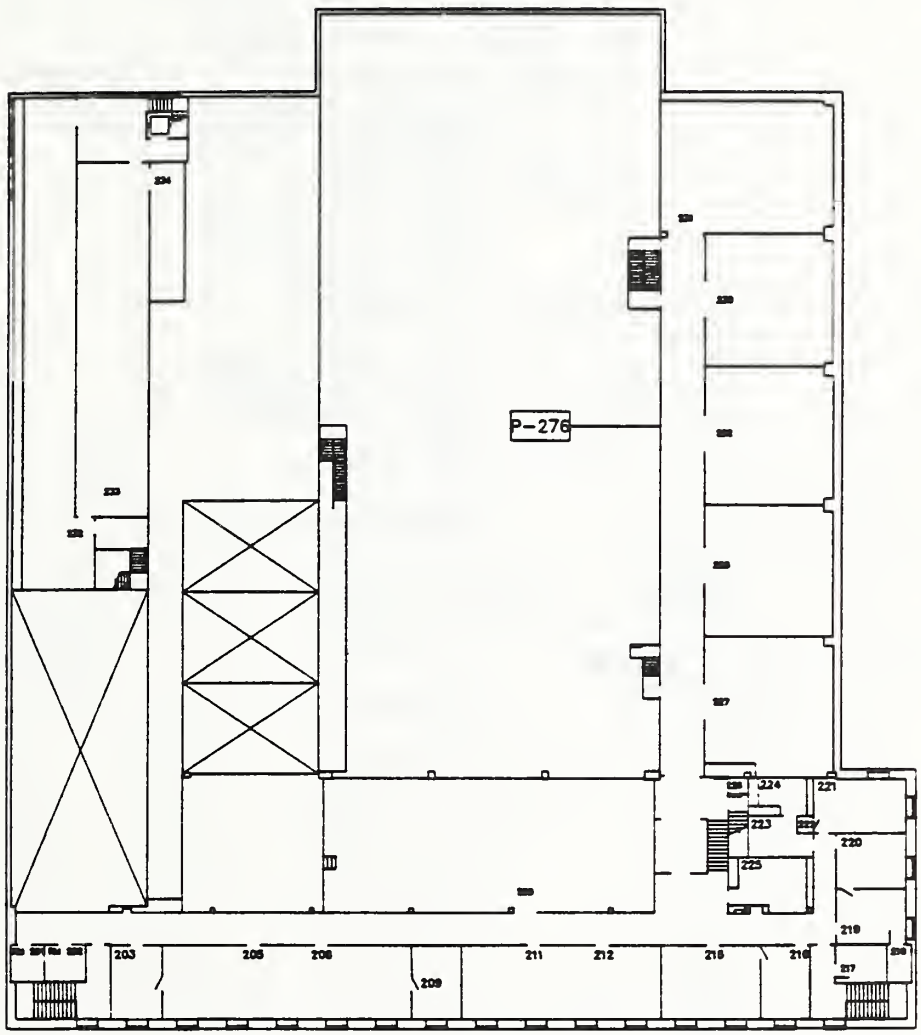
PERIMETER FOUNDATION WALLS WERE SURVEYED WHERE SOME AREAS OF DELAMINATION, MINOR CRACKING AND INSUFFICIENT REINFORCEMENT CONCRETE COVER WERE OBSERVED.



BUILDING 202 – FIRST FLOOR

DATE OF LAST REVISION: 11/20/90

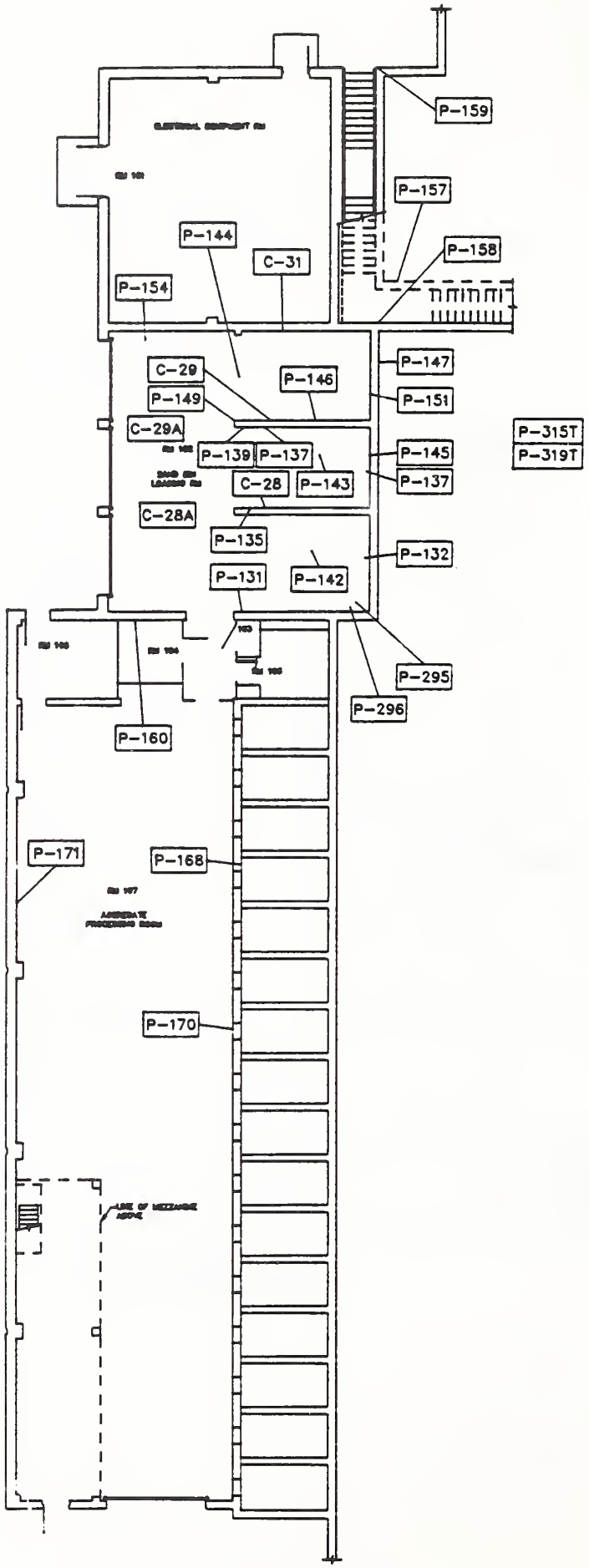
FIGURE 2



BUILDING 202 – SECOND FLOOR

DATE OF LAST REVISION: 11/20/90

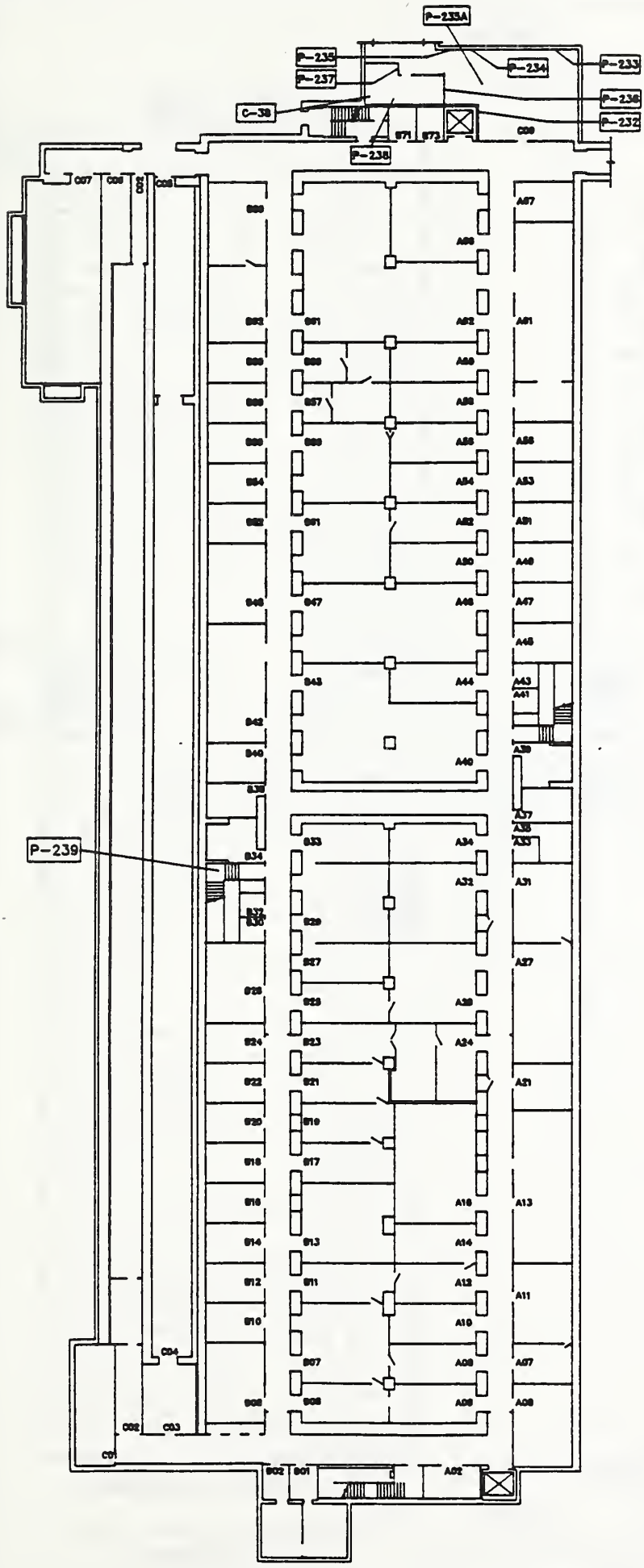
FIGURE 3



BUILDING 206 – FIRST FLOOR

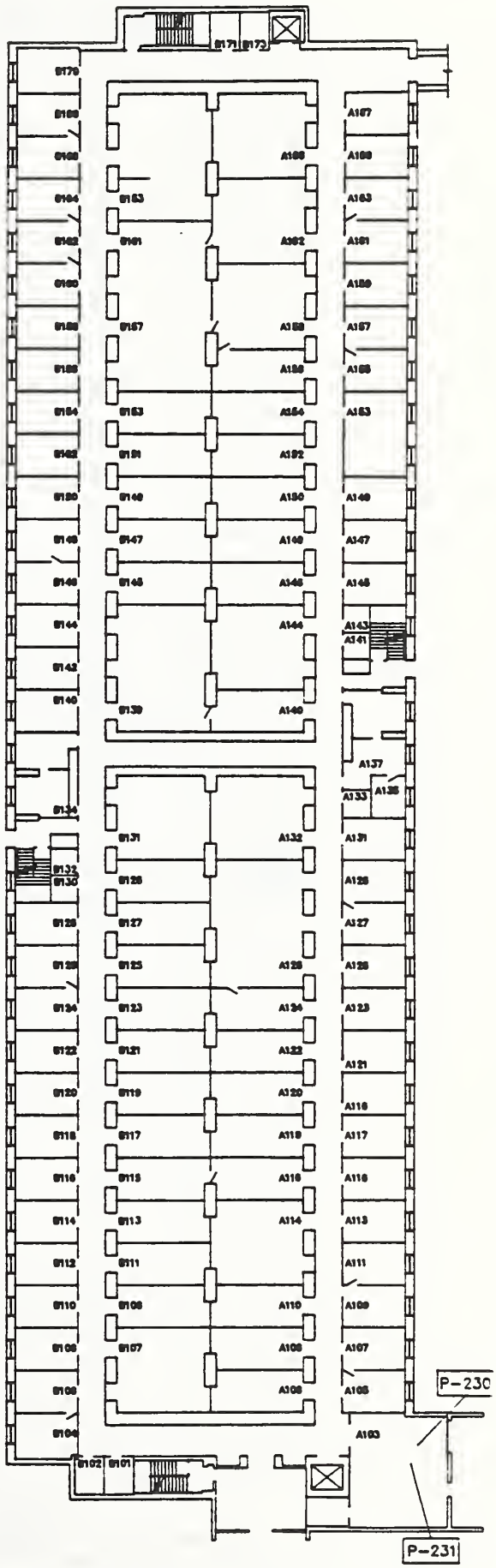
DATE OF LAST REVISION: 11/15/90

FIGURE 4



BUILDING 220 – BASEMENT FLOOR

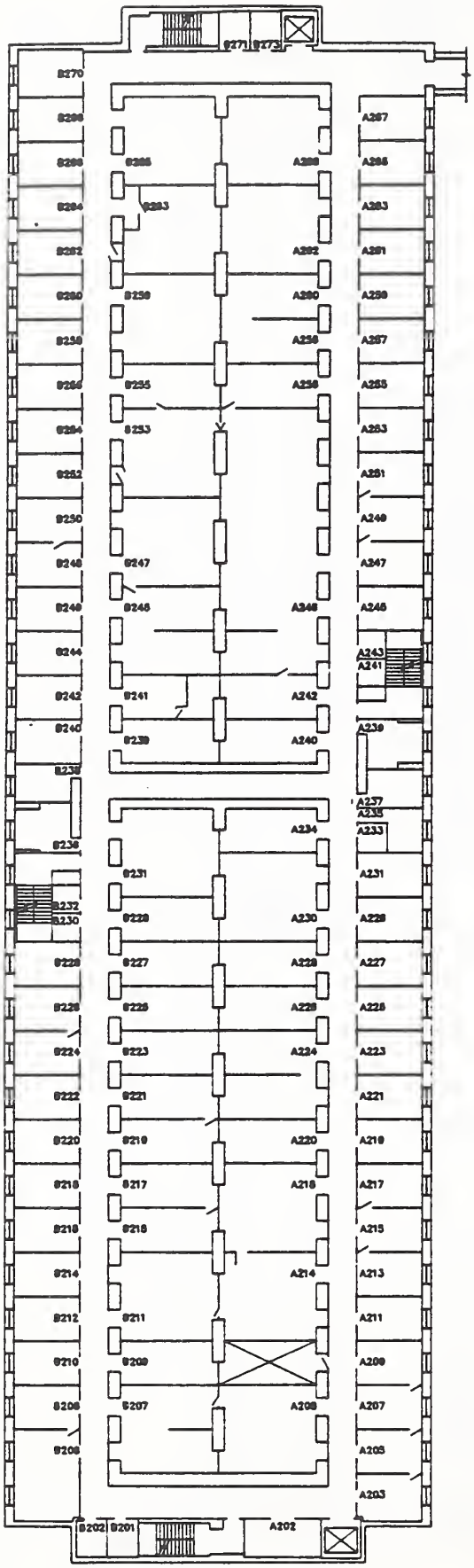
DATE OF LAST REVISION 11/16/00



BUILDING 220 – FIRST FLOOR

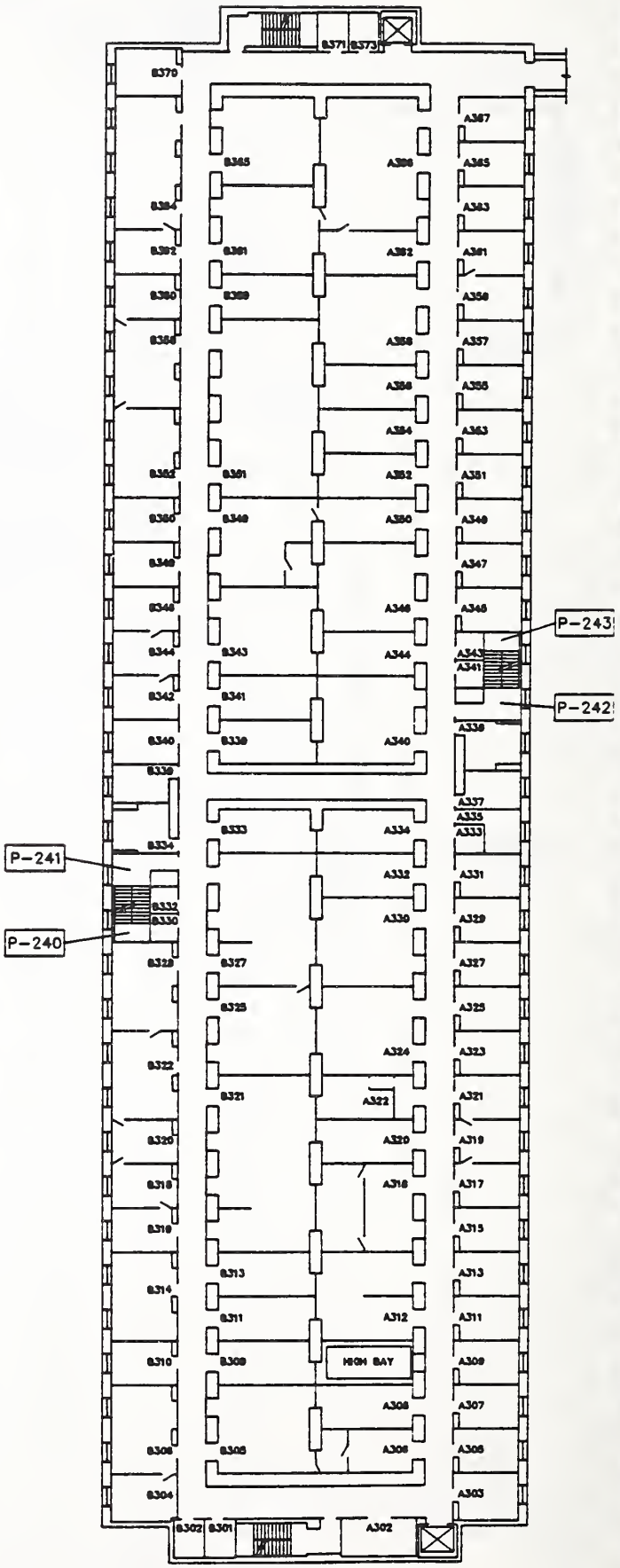
DATE OF LAST REVISION 11/20/00

FIGURE 5



BUILDING 220 – SECOND FLOOR

DATE OF LAST REVISION: 11/21/90



BUILDING 220 – THIRD FLOOR

DATE OF LAST REVISION: 11/21/90

FIGURE 6

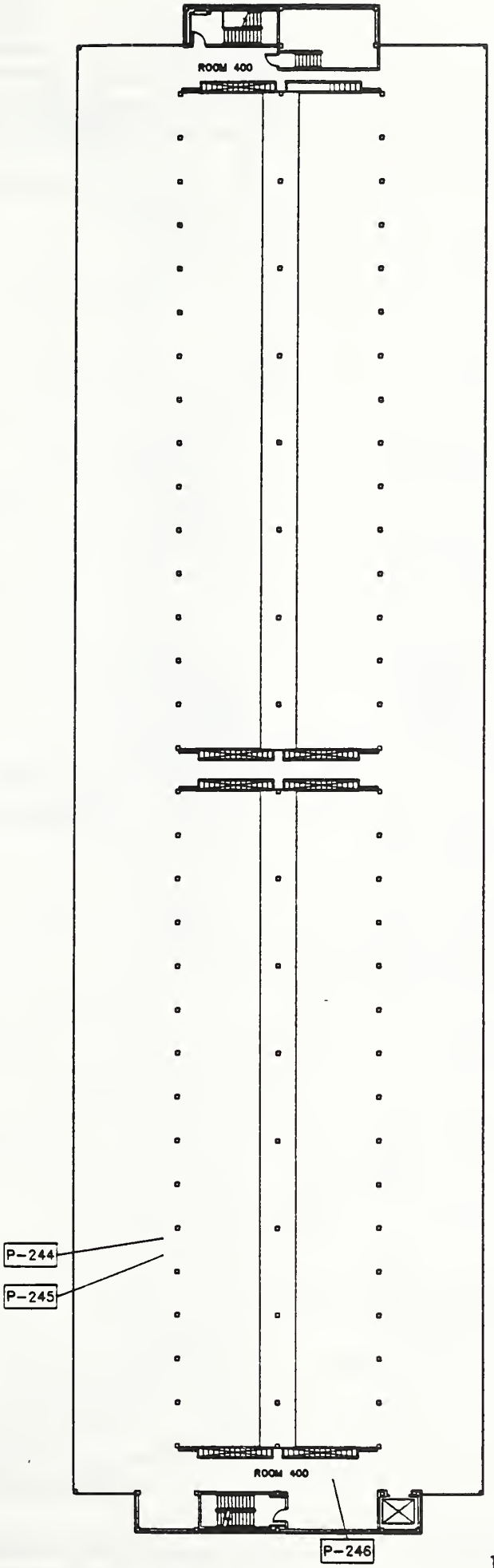


FIGURE 7

BUILDING 220 – ATTIC FLOOR

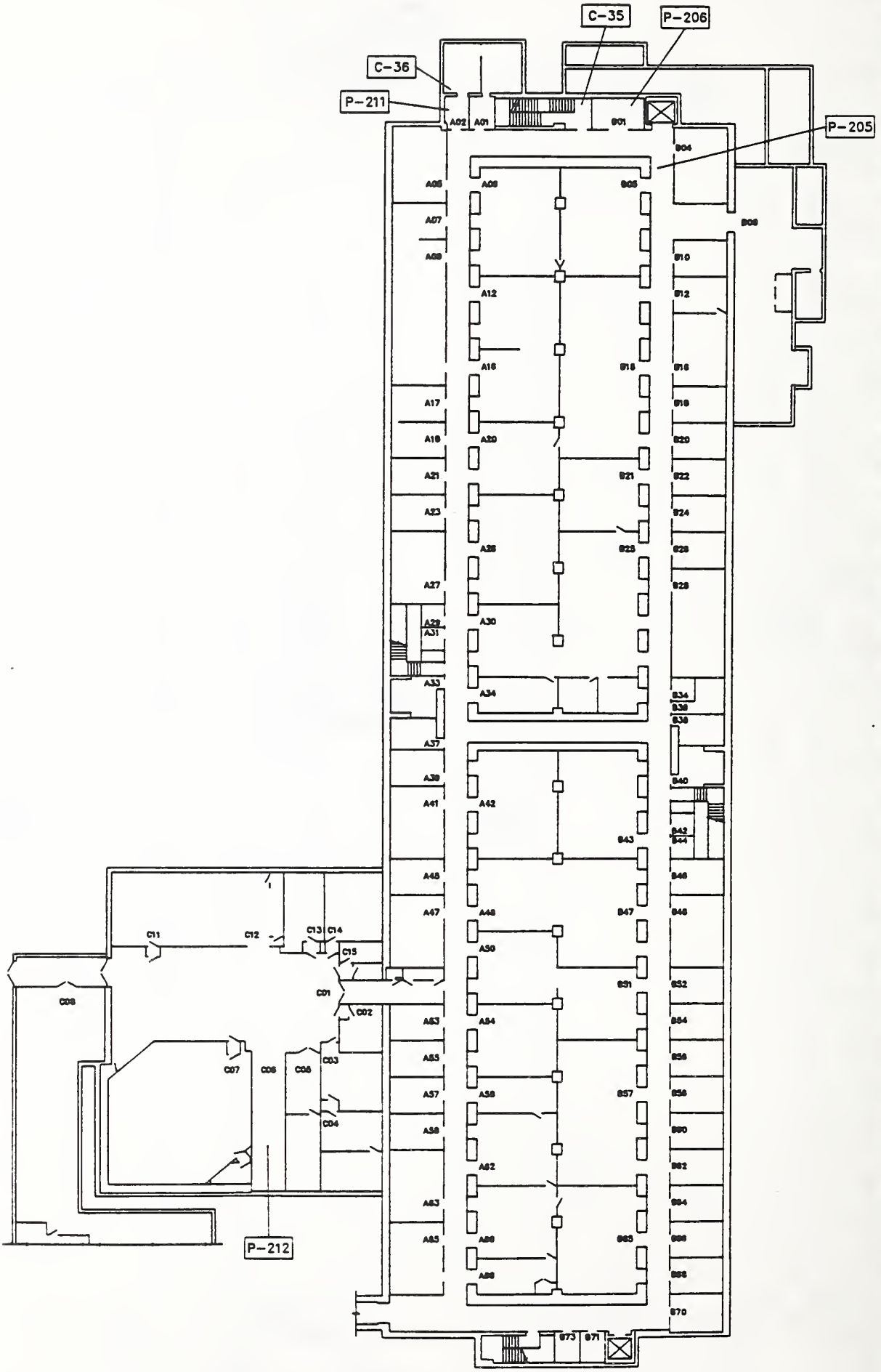
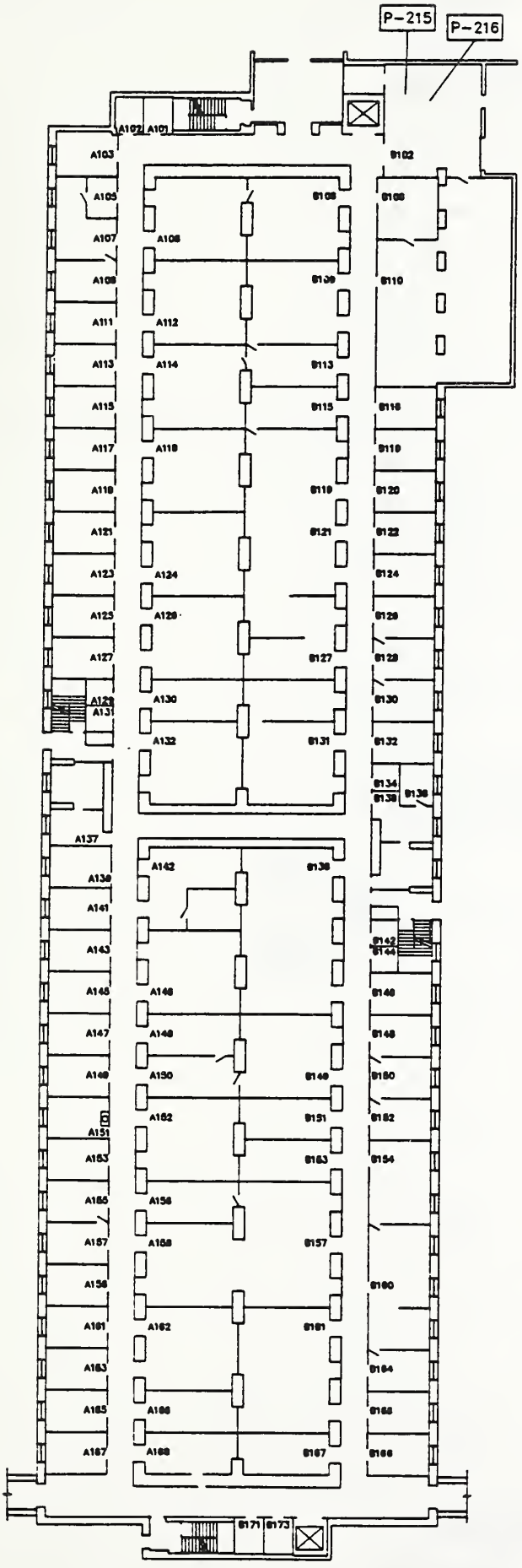


FIGURE 8

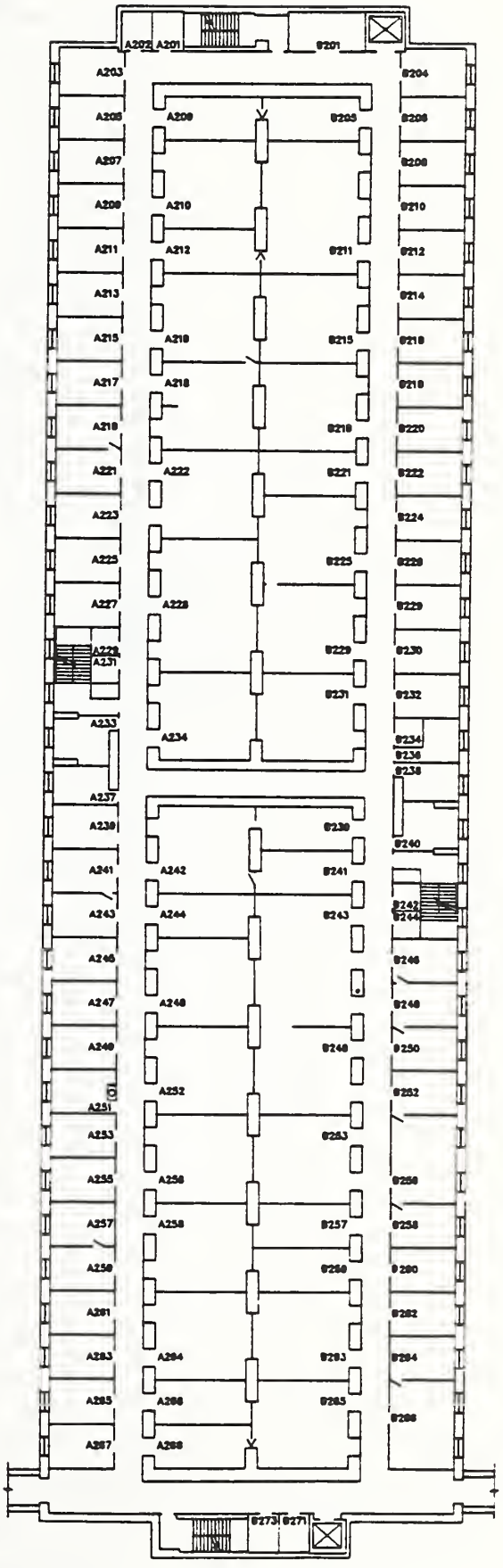
BUILDING 221 – BASEMENT FLOOR

DATE OF LAST REVISION: 11/19/90



BUILDING 221 – 1ST FLOOR

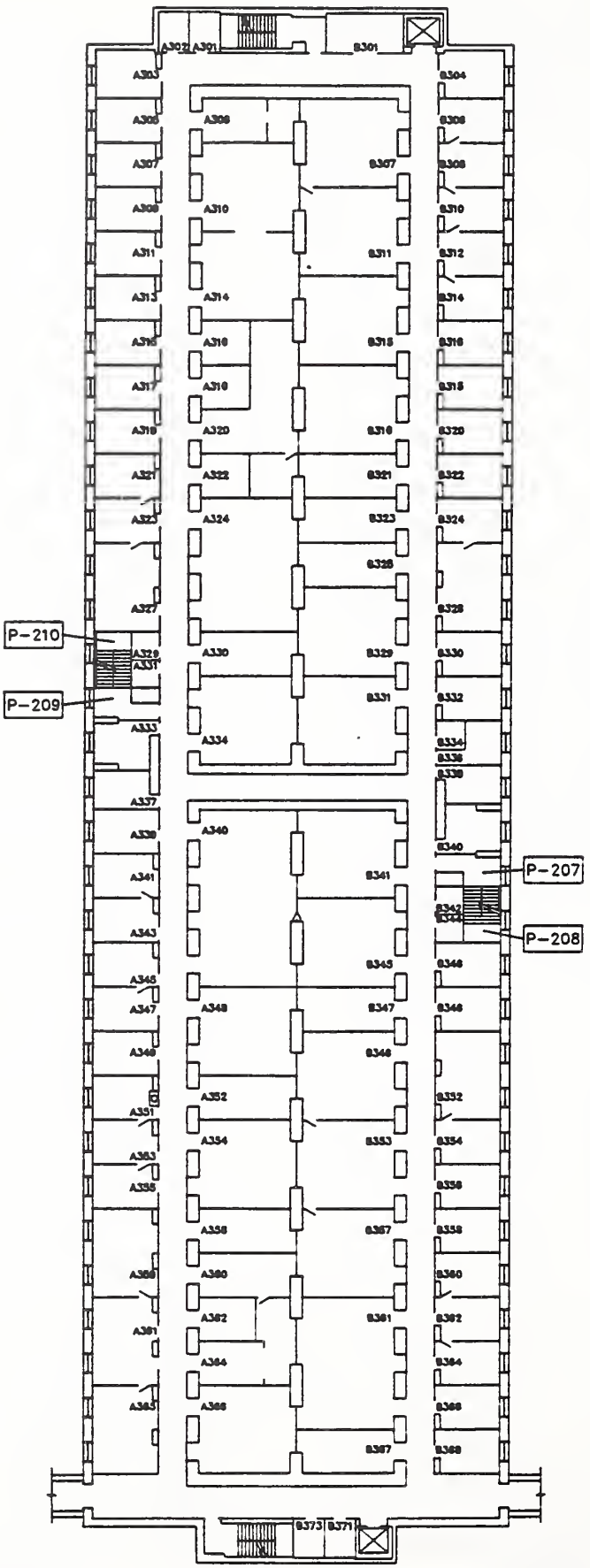
DATE OF LAST REVISION: 11/19/90



BUILDING 221 – SECOND FLOOR

DATE OF LAST REVISION: 11/19/90

FIGURE 9



BUILDING 221 – THIRD FLOOR

DATE OF LAST REVISION: 11/19/80

FIGURE 10

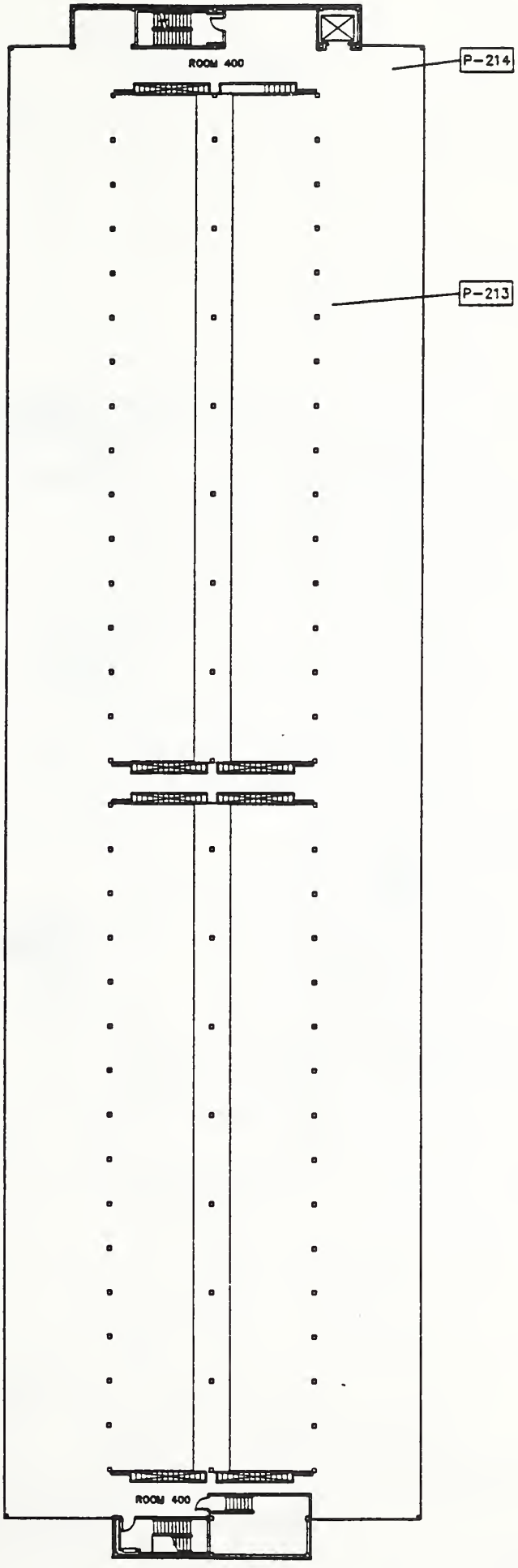
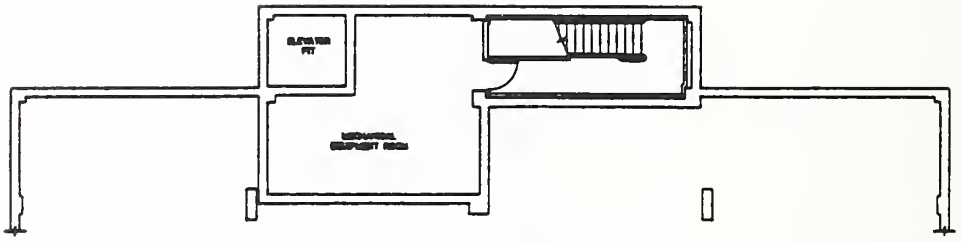
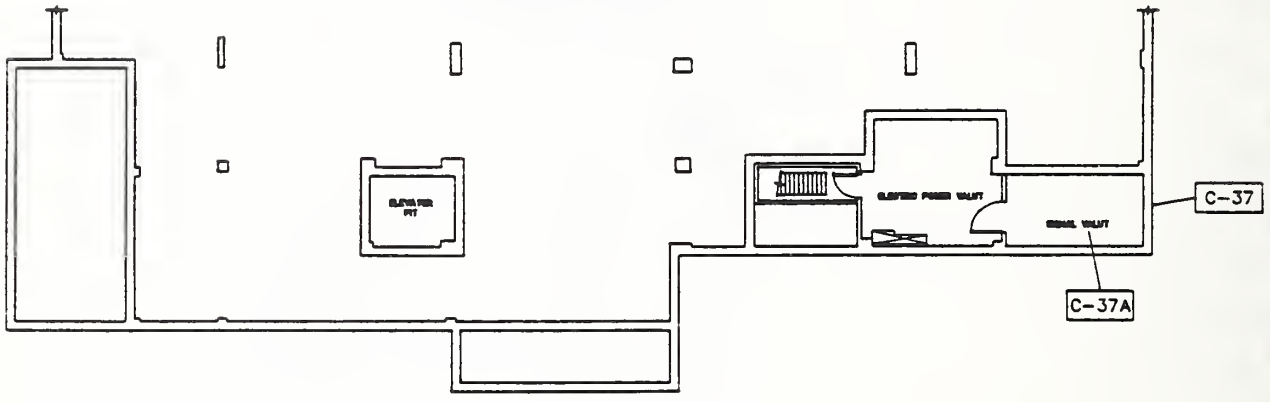


FIGURE 11

BUILDING 221 – ATTIC FLOOR

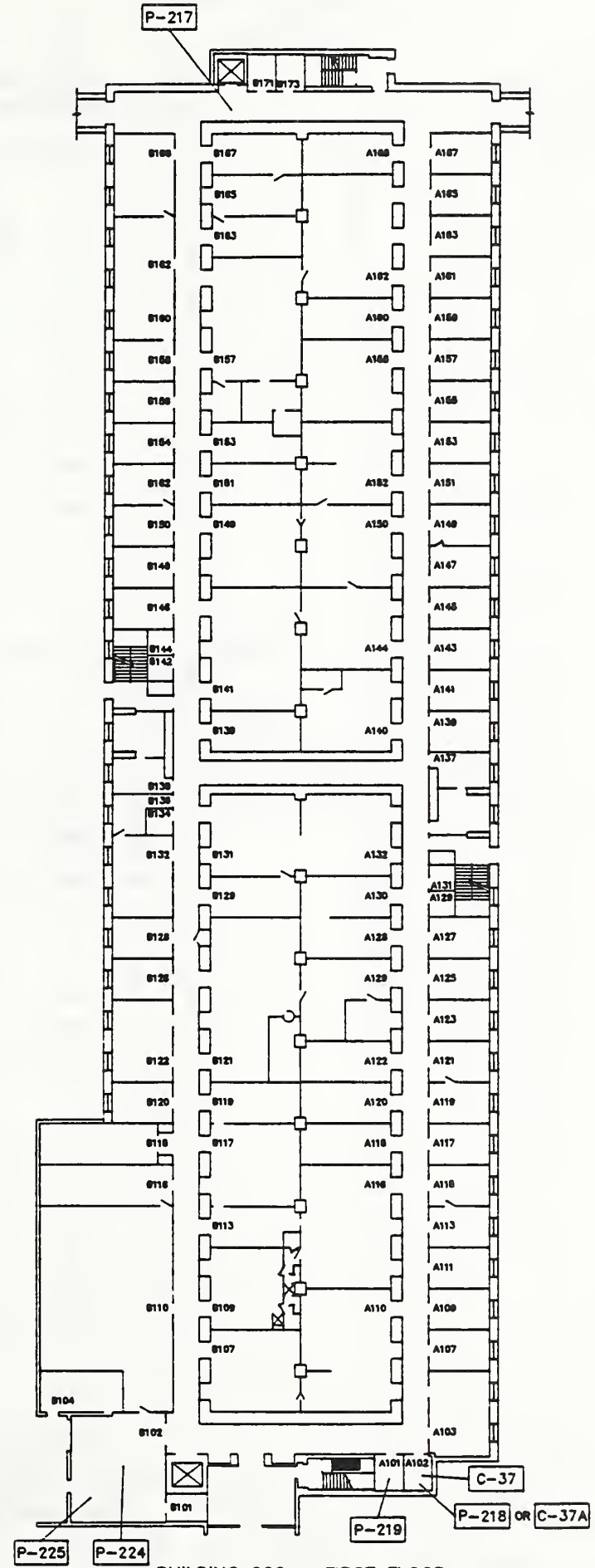


BLDG. 222 – BASEMENT
CORE 4



BLDG. 222 – BASEMENT
CORE 1

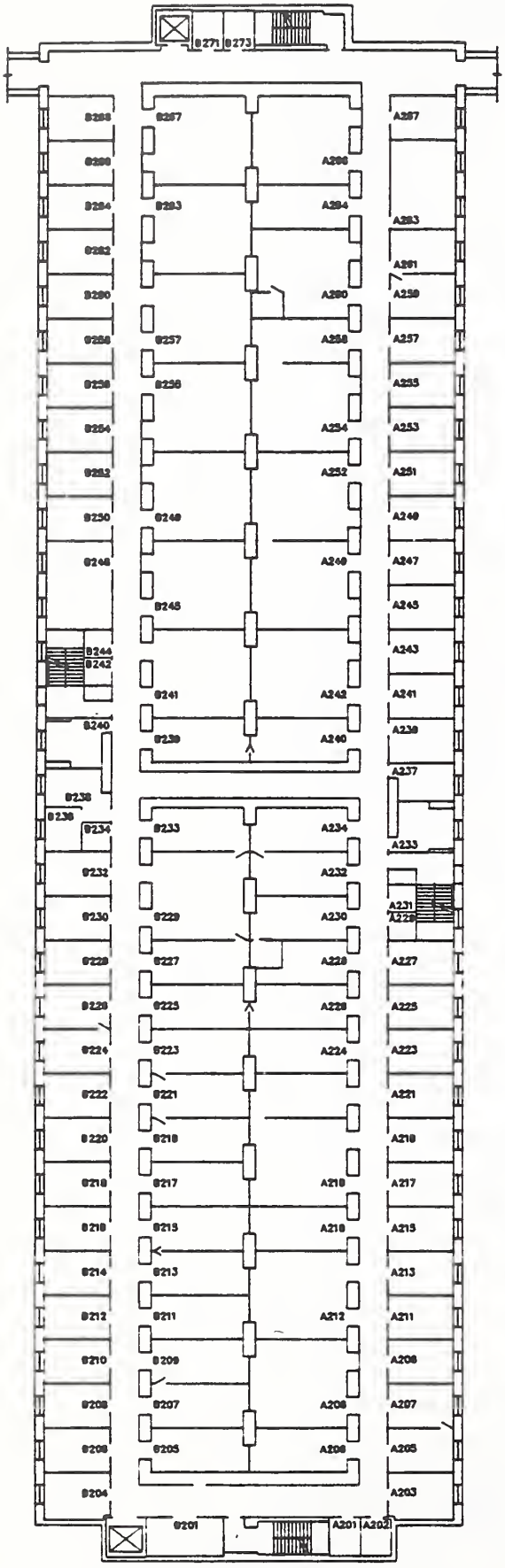
FIGURE 12



BUILDING 222 – FIRST FLOOR

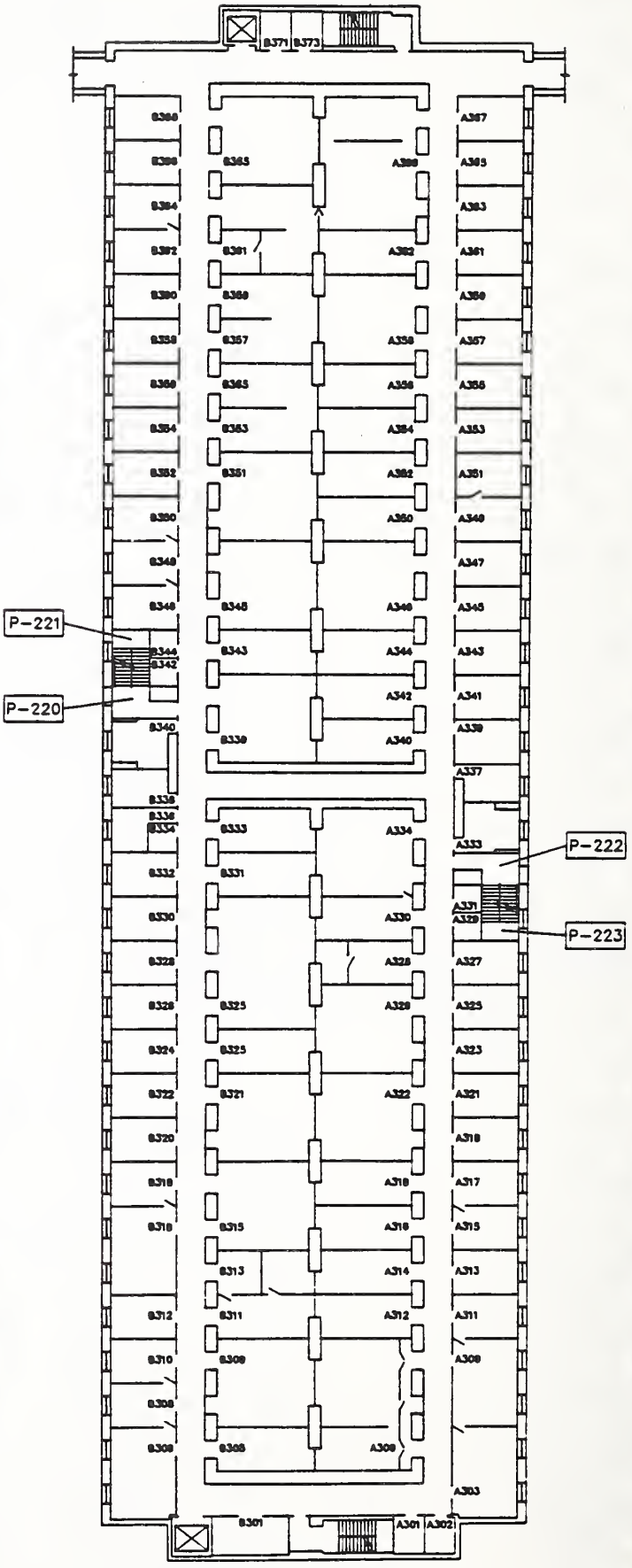
DATE OF LAST REVISION: 11/16/00

FIGURE 13



BUILDING 222 – SECOND FLOOR

DATE OF LAST REVISION: 11/18/90



BUILDING 222 – THIRD FLOOR

DATE OF LAST REVISION: 11/18/90

FIGURE 14

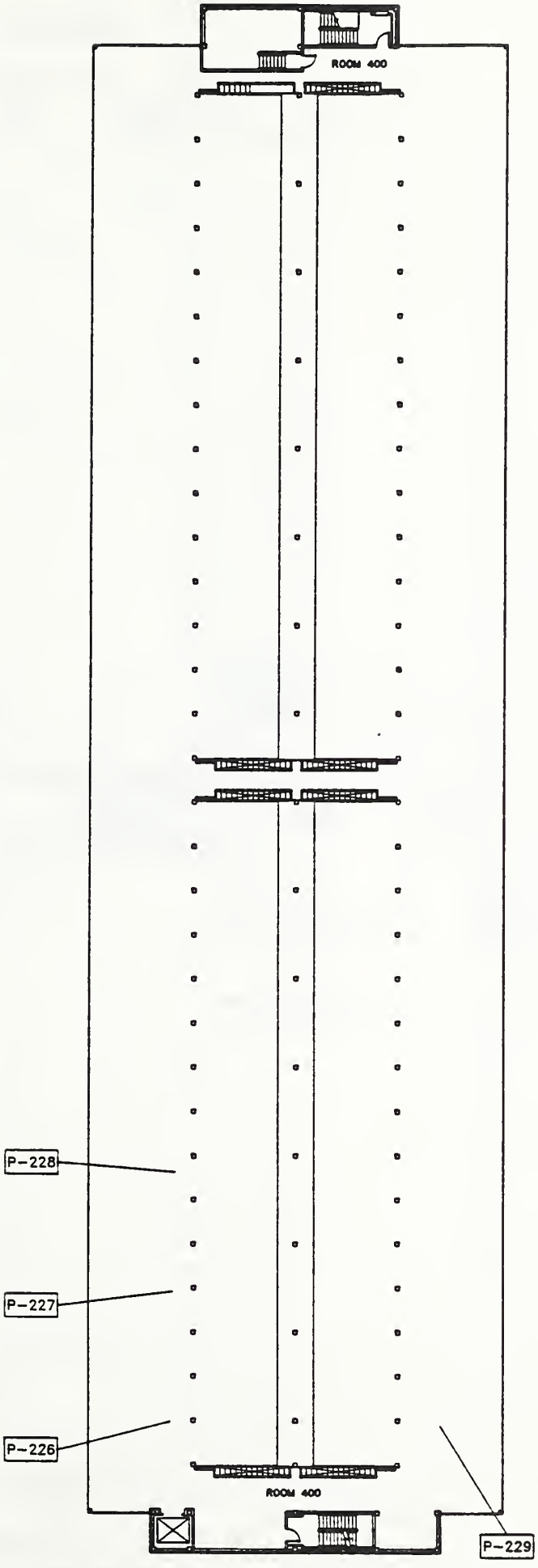
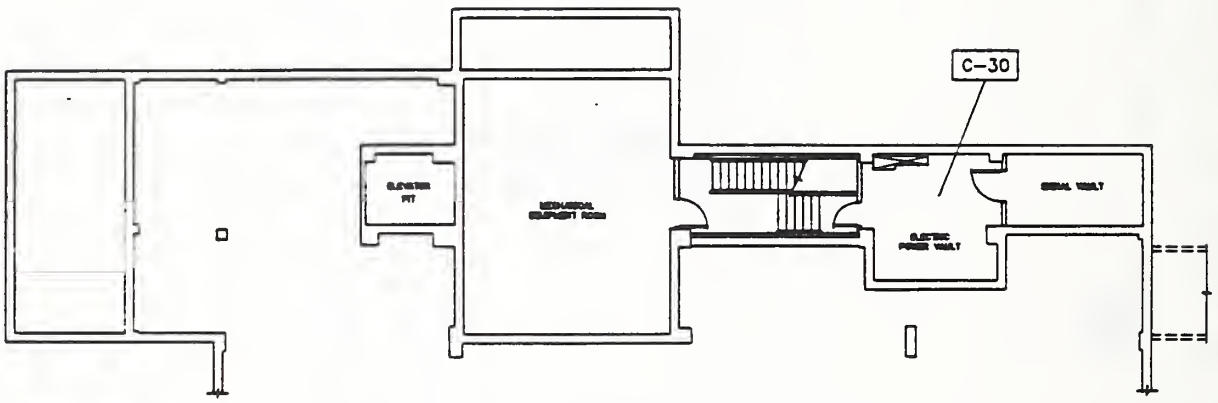


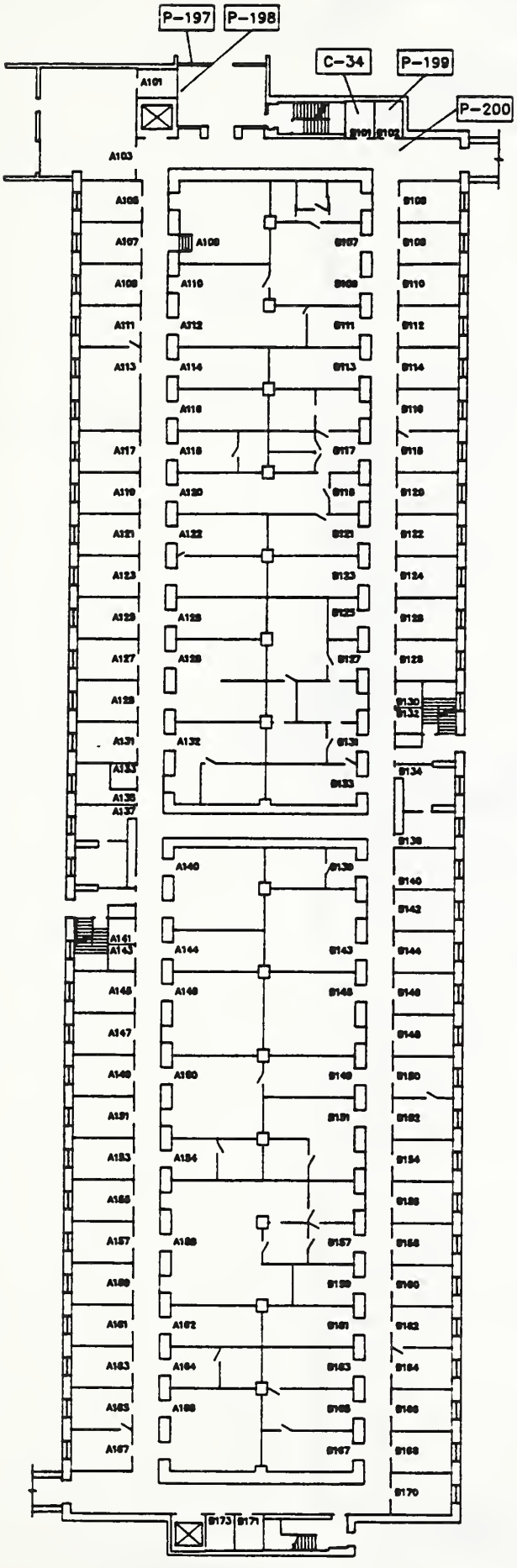
FIGURE 15

BUILDING 222 – ATTIC FLOOR



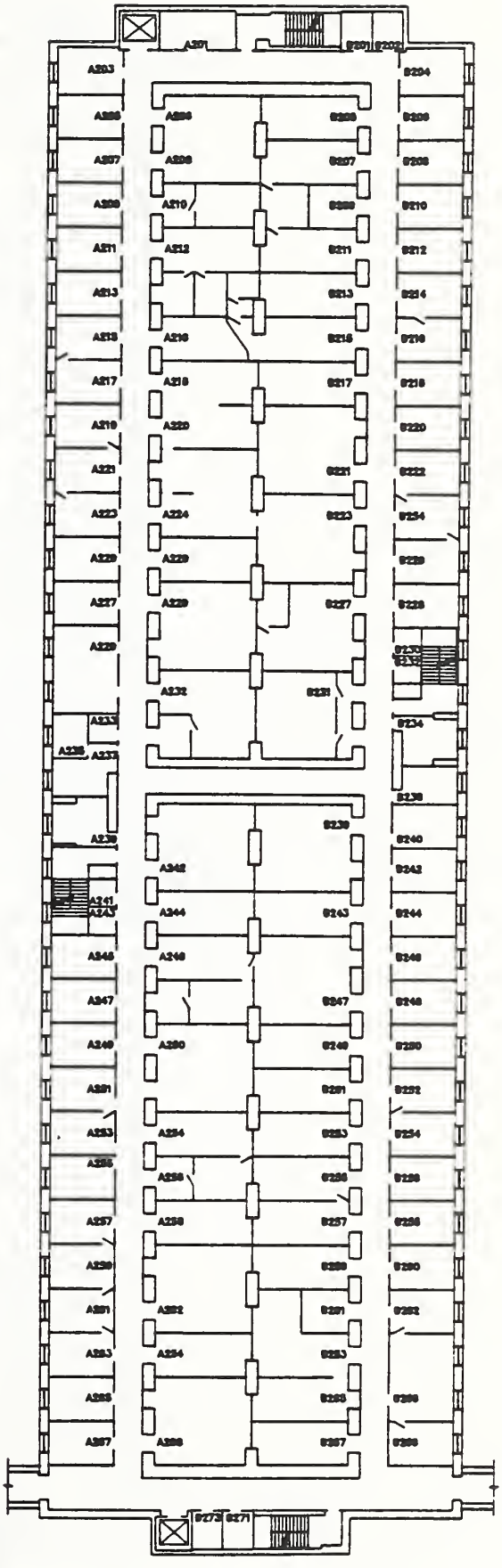
BLDG. 223 – BASEMENT
CORE 1

FIGURE 16



BUILDING 223 – FIRST FLOOR

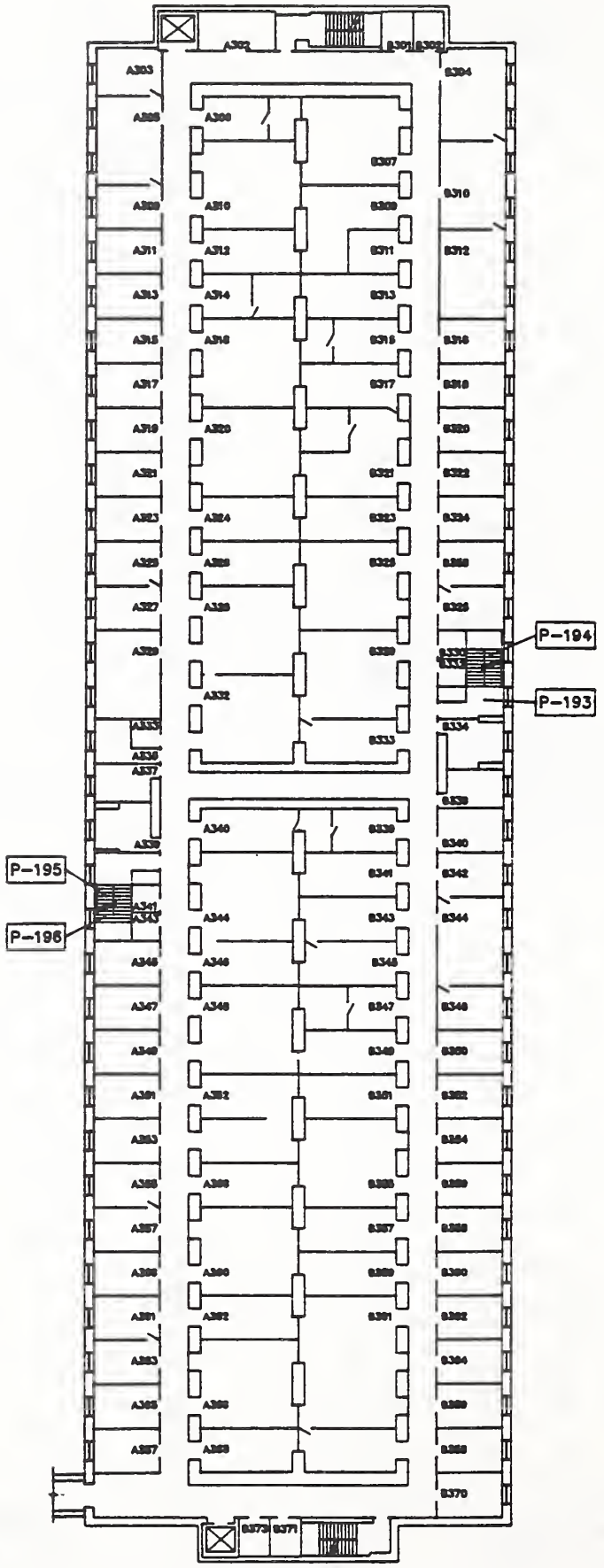
DATE OF LAST REVISION: 11/15/99



BUILDING 223 – SECOND FLOOR

DATE OF LAST REVISION: 11/15/99

FIGURE 17



BUILDING 223 – THIRD FLOOR

FIGURE 18

DATE OF LAST REVISION: 11/15/90

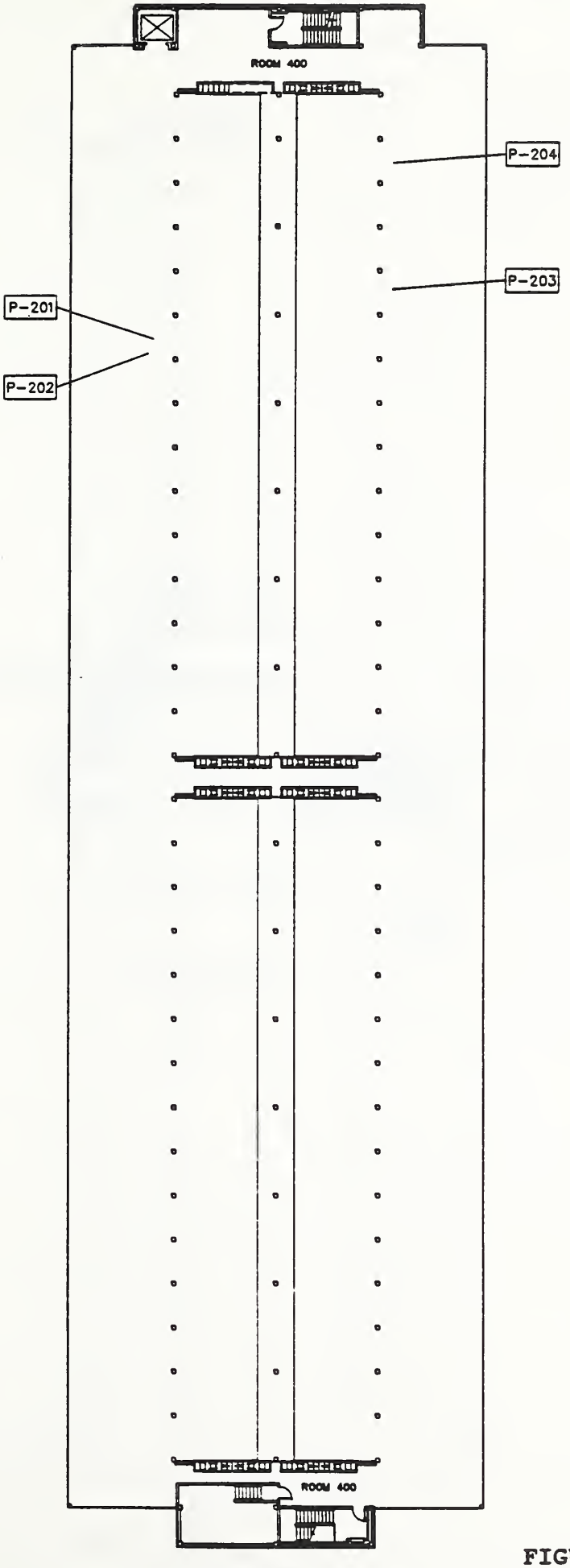
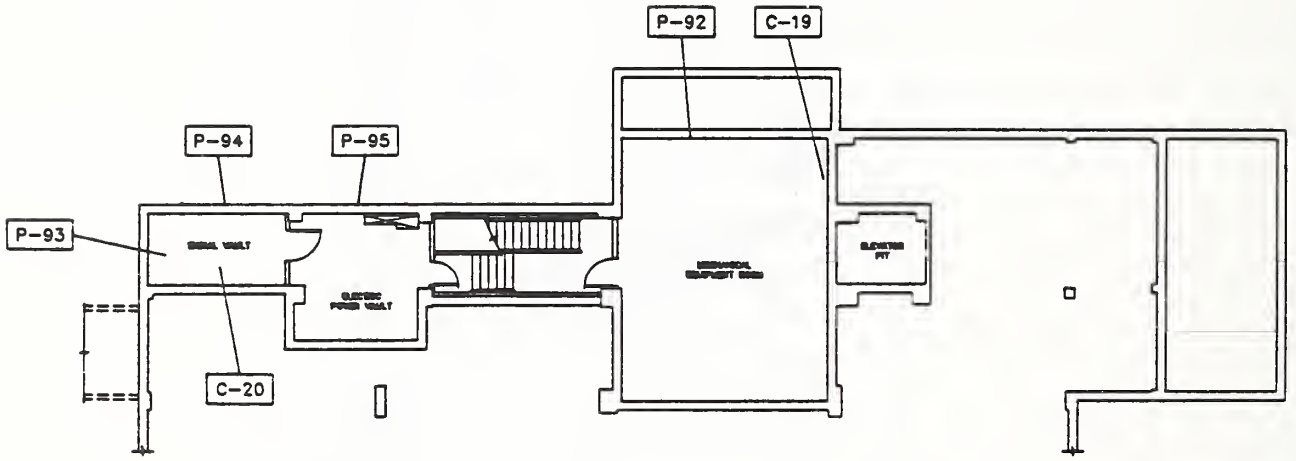


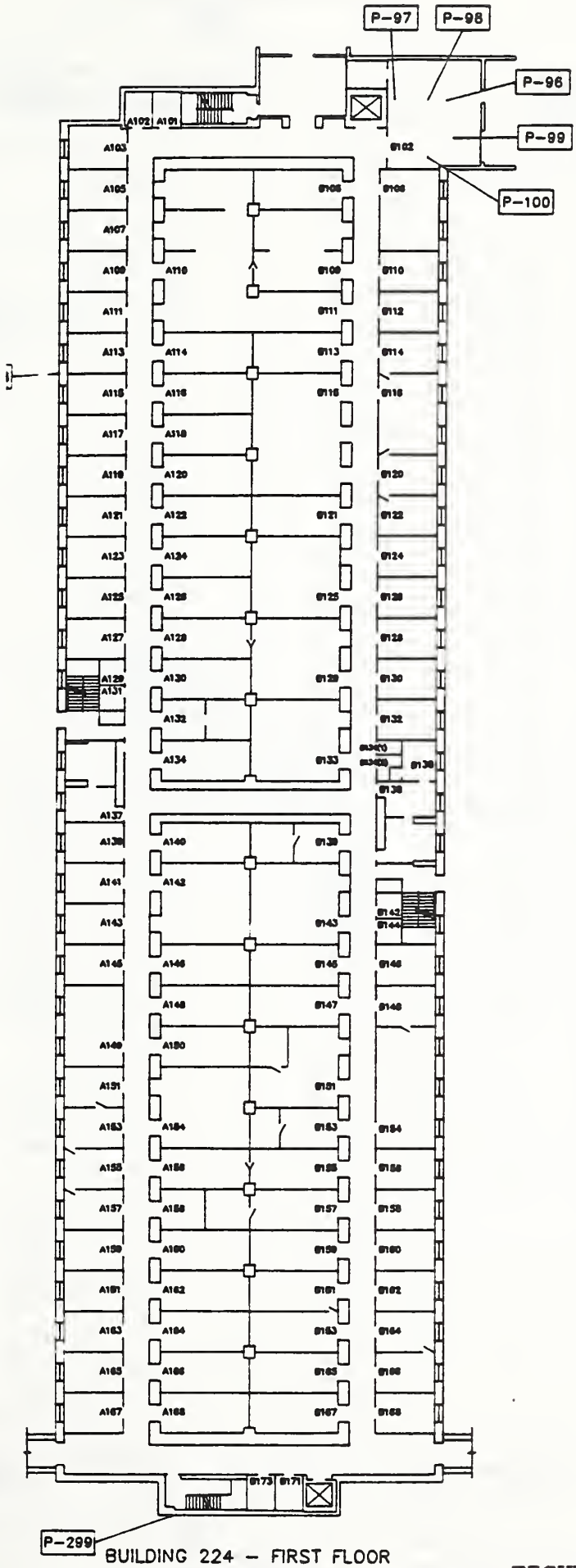
FIGURE 19

BUILDING 223 – ATTIC FLOOR



BLDG. 224 – BASEMENT
CORE 1

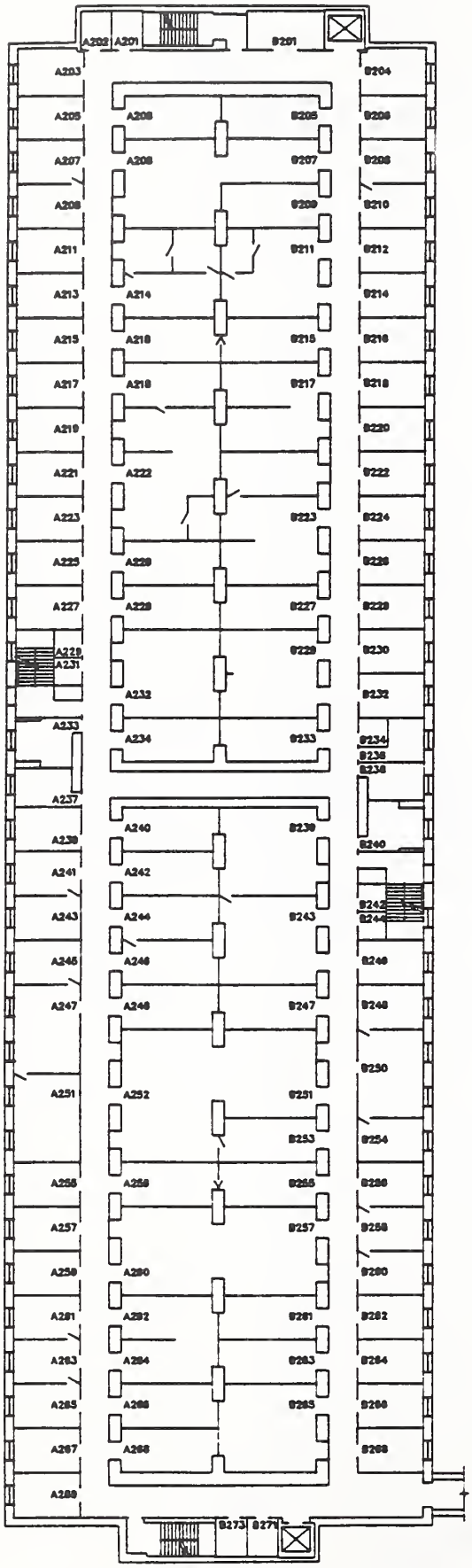
FIGURE 20



BUILDING 224 – FIRST FLOOR

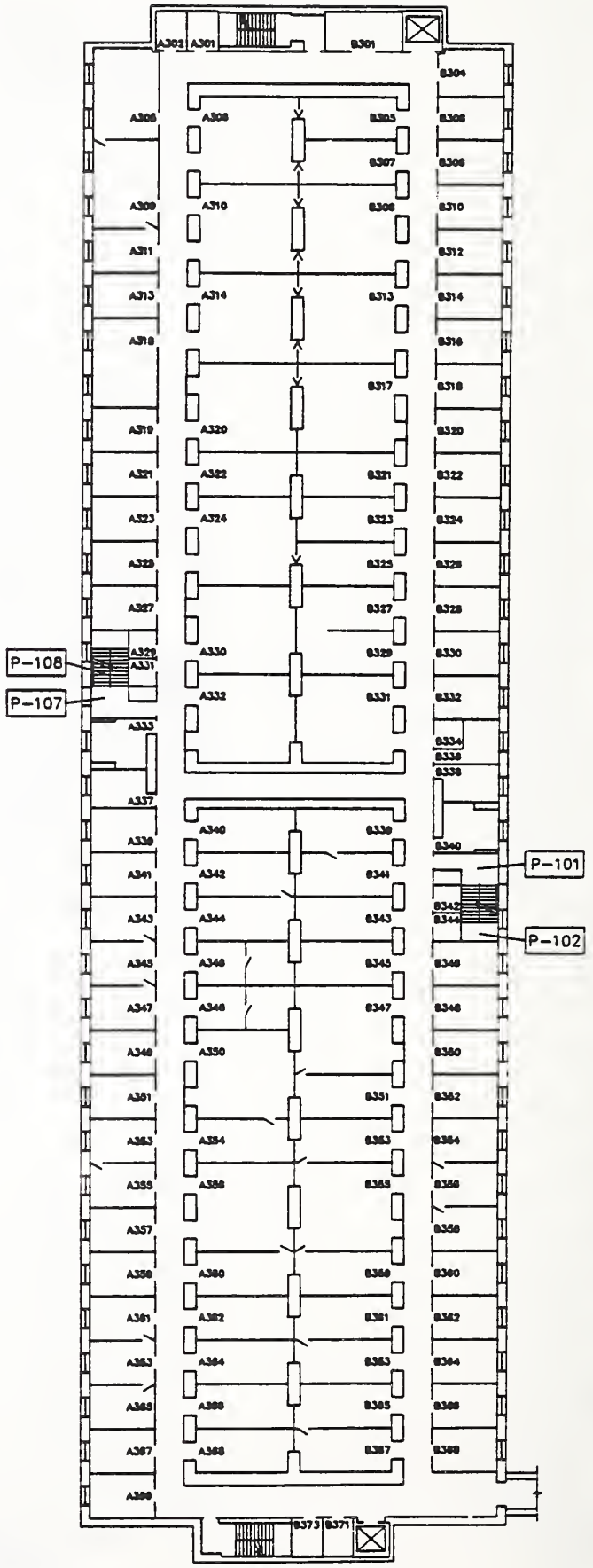
DATE OF LAST REVISION: 11/14/00

FIGURE 21



BUILDING 224 – SECOND FLOOR

DATE OF LAST REVISION: 11/14/90



BUILDING 224 – THIRD FLOOR

DATE OF LAST REVISION: 11/16/90

FIGURE 22

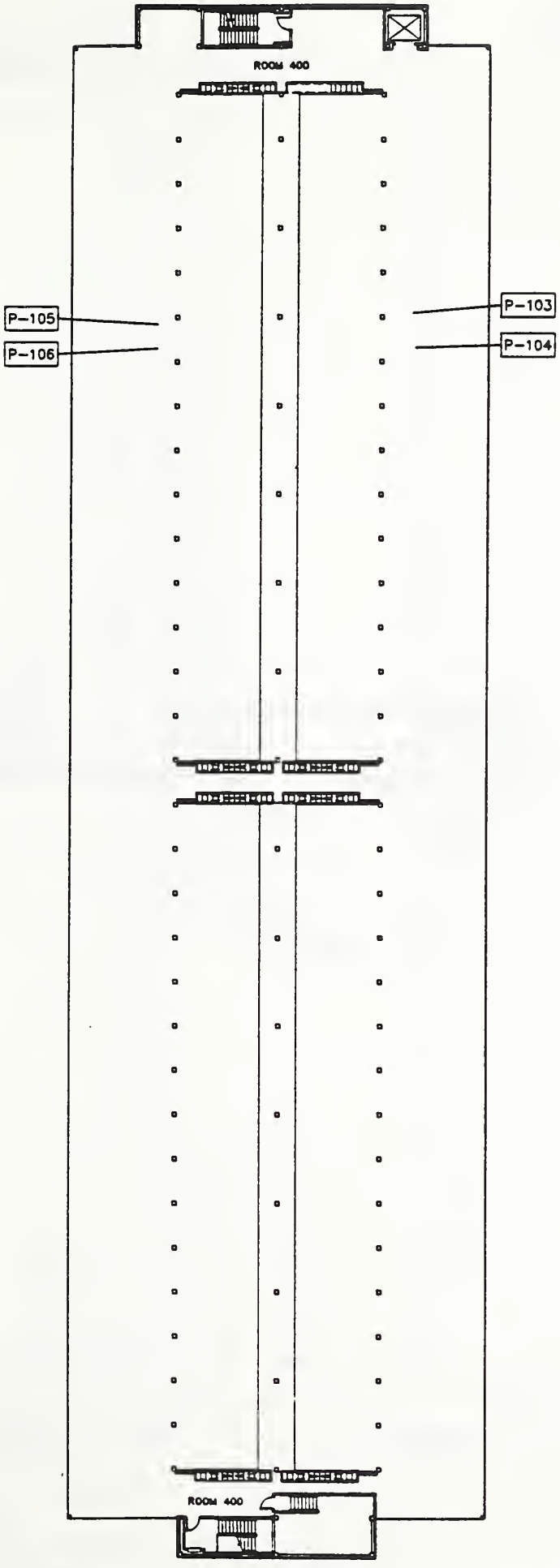
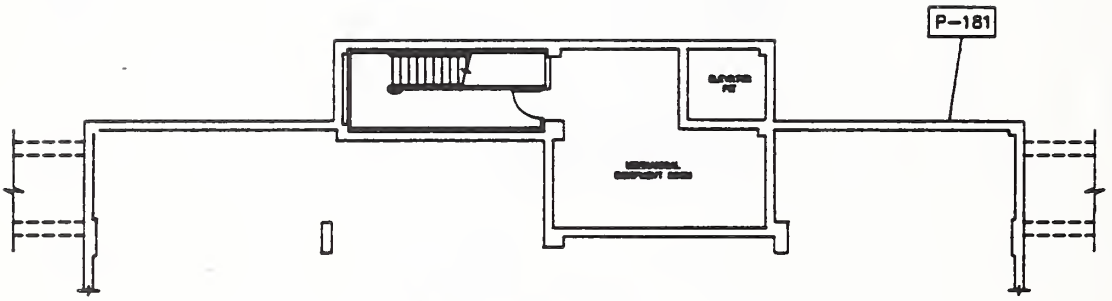


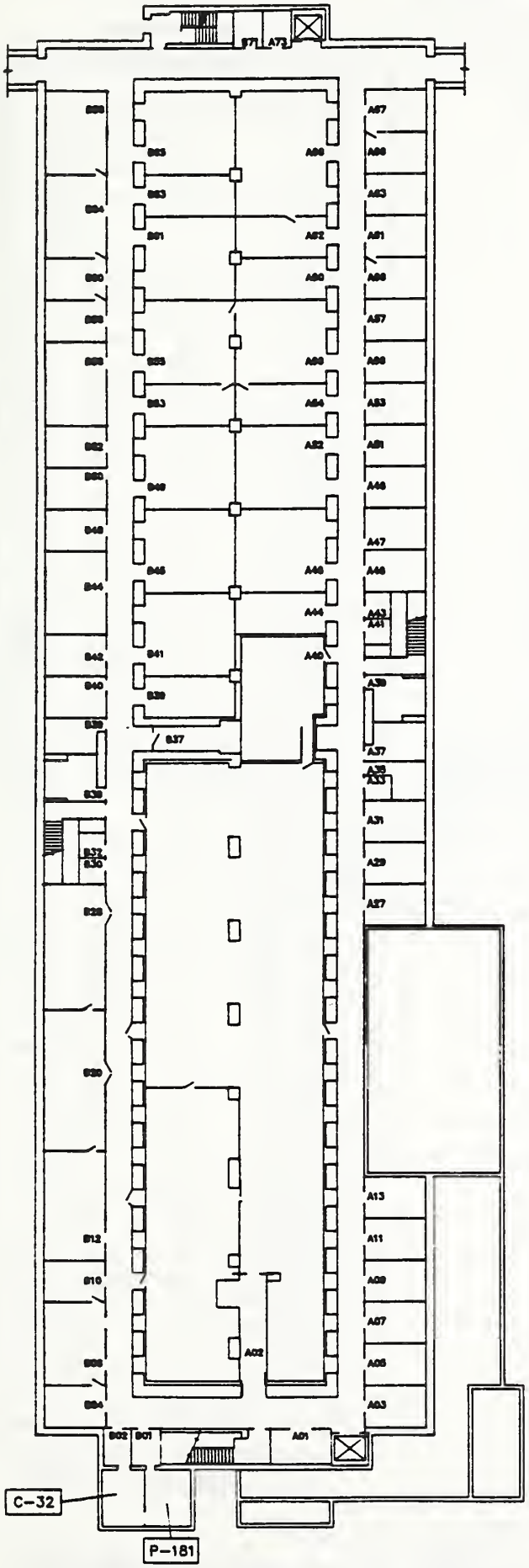
FIGURE 23

BUILDING 224 – ATTIC FLOOR



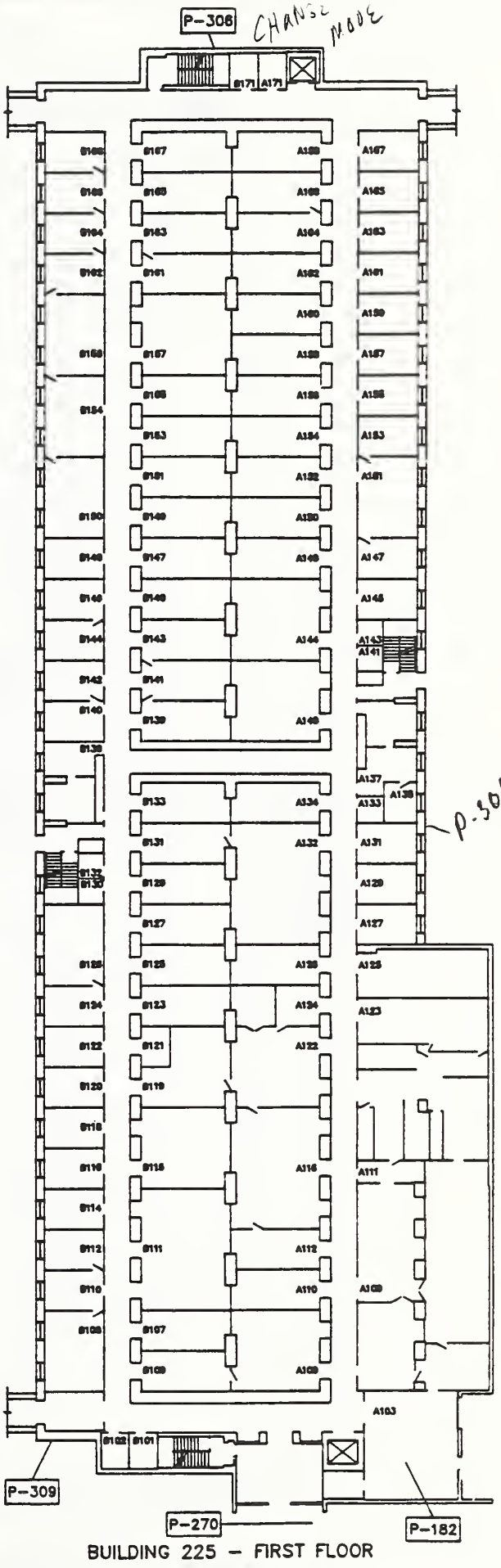
BLDG. 225 - SUB-BASEMENT
CORE 4

FIGURE 24



BUILDING 225 – BASEMENT FLOOR

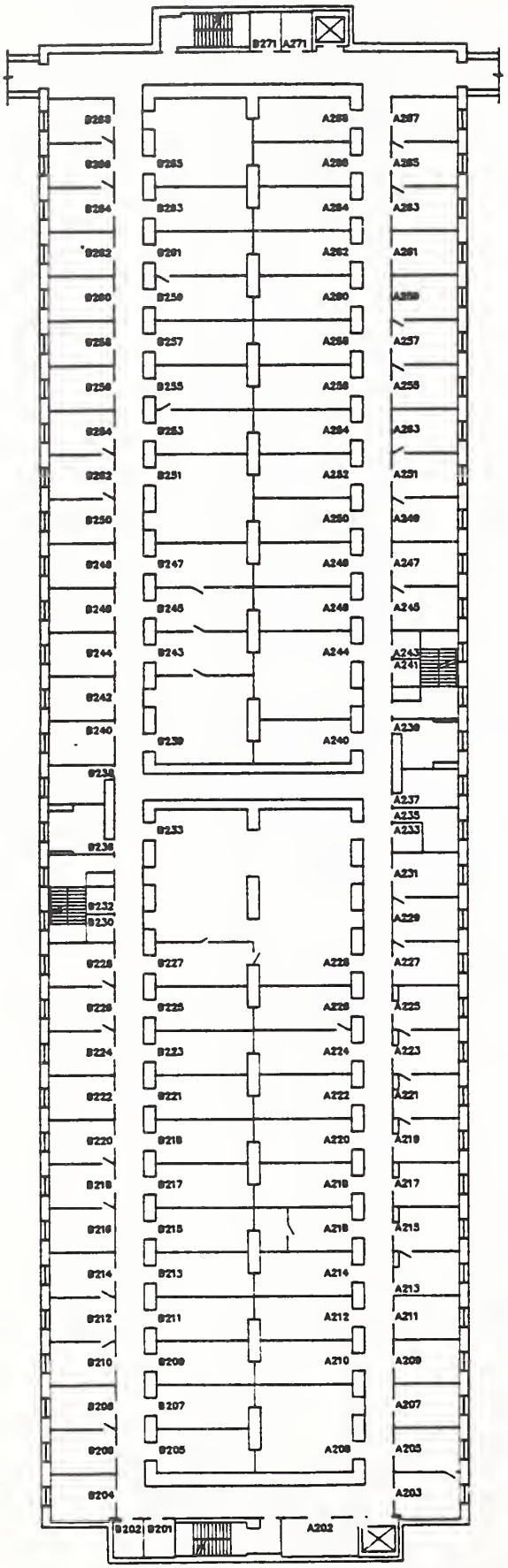
DATE OF LAST REVISION: 11/15/90



BUILDING 225 – FIRST FLOOR

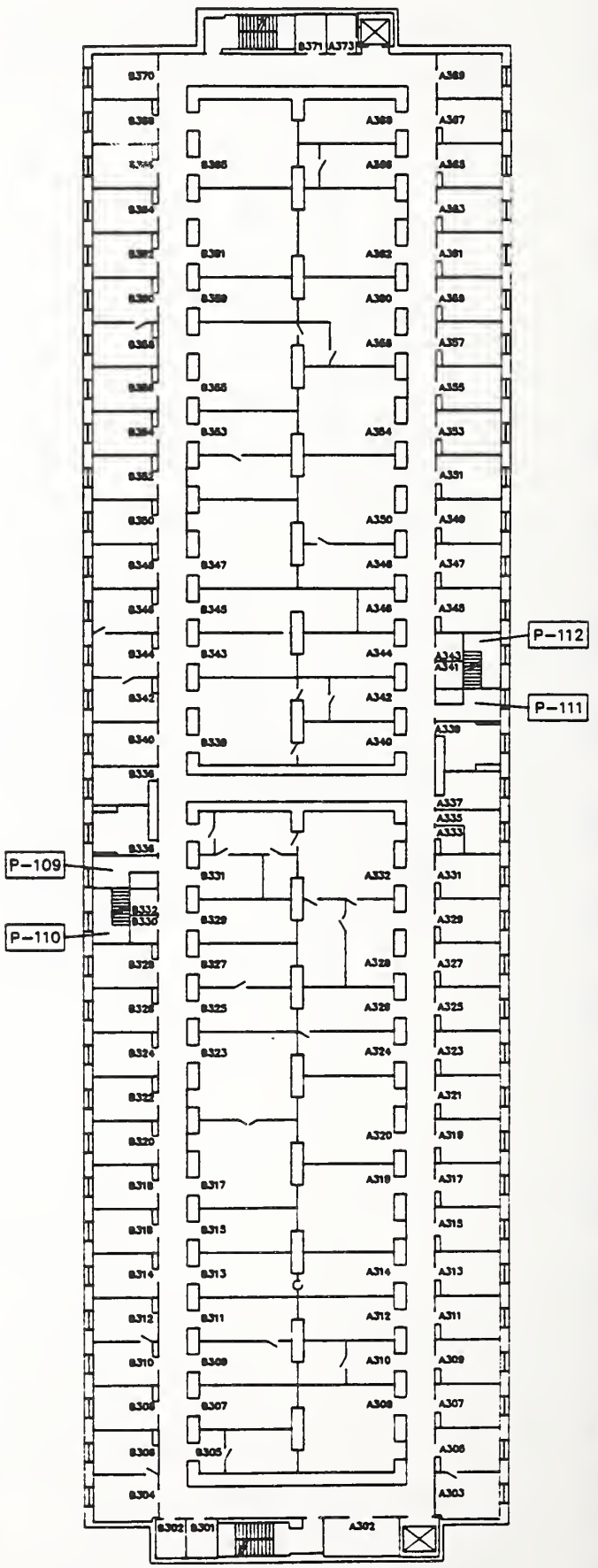
DATE OF LAST REVISION: 11/15/90

FIGURE 25



BUILDING 225 – SECOND FLOOR

DATE OF LAST REVISION: 11/15/90



BUILDING 225 – THIRD FLOOR

DATE OF LAST REVISION: 11/19/90

FIGURE 26

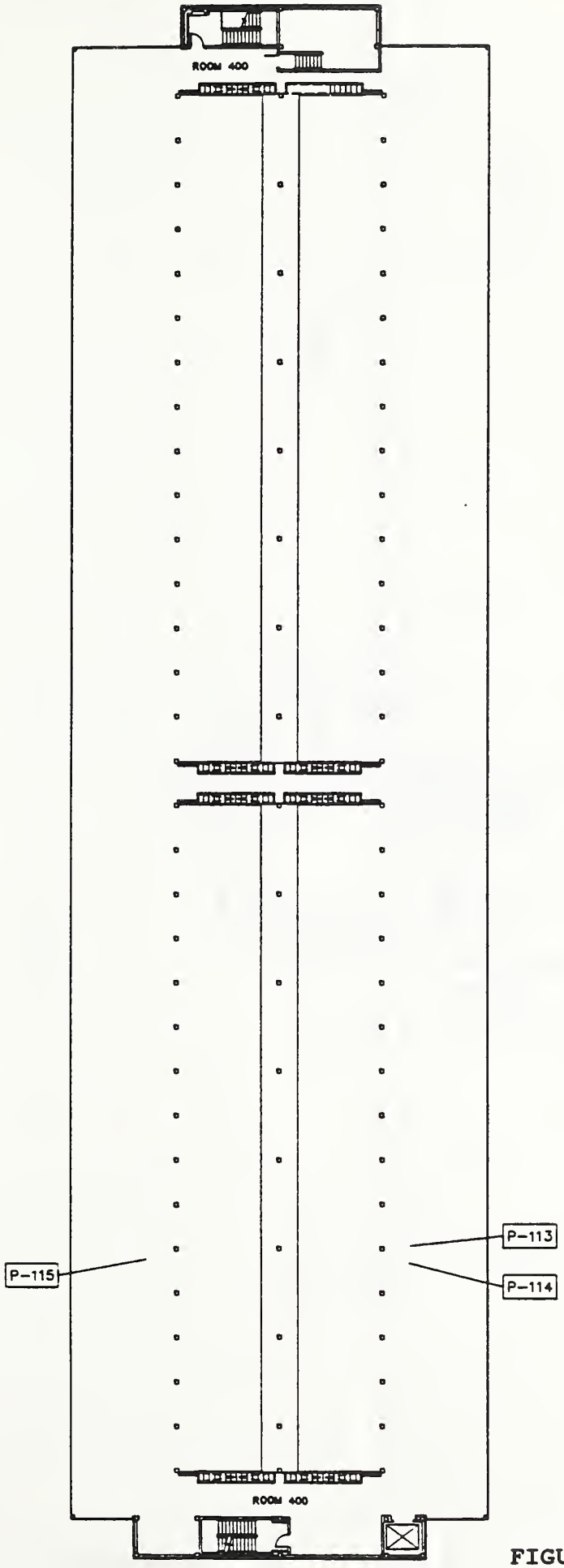
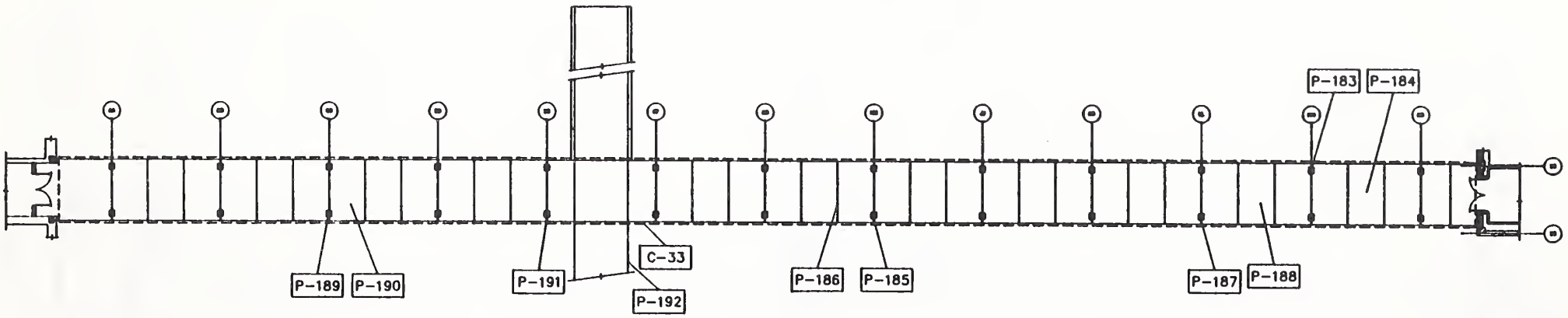


FIGURE 27

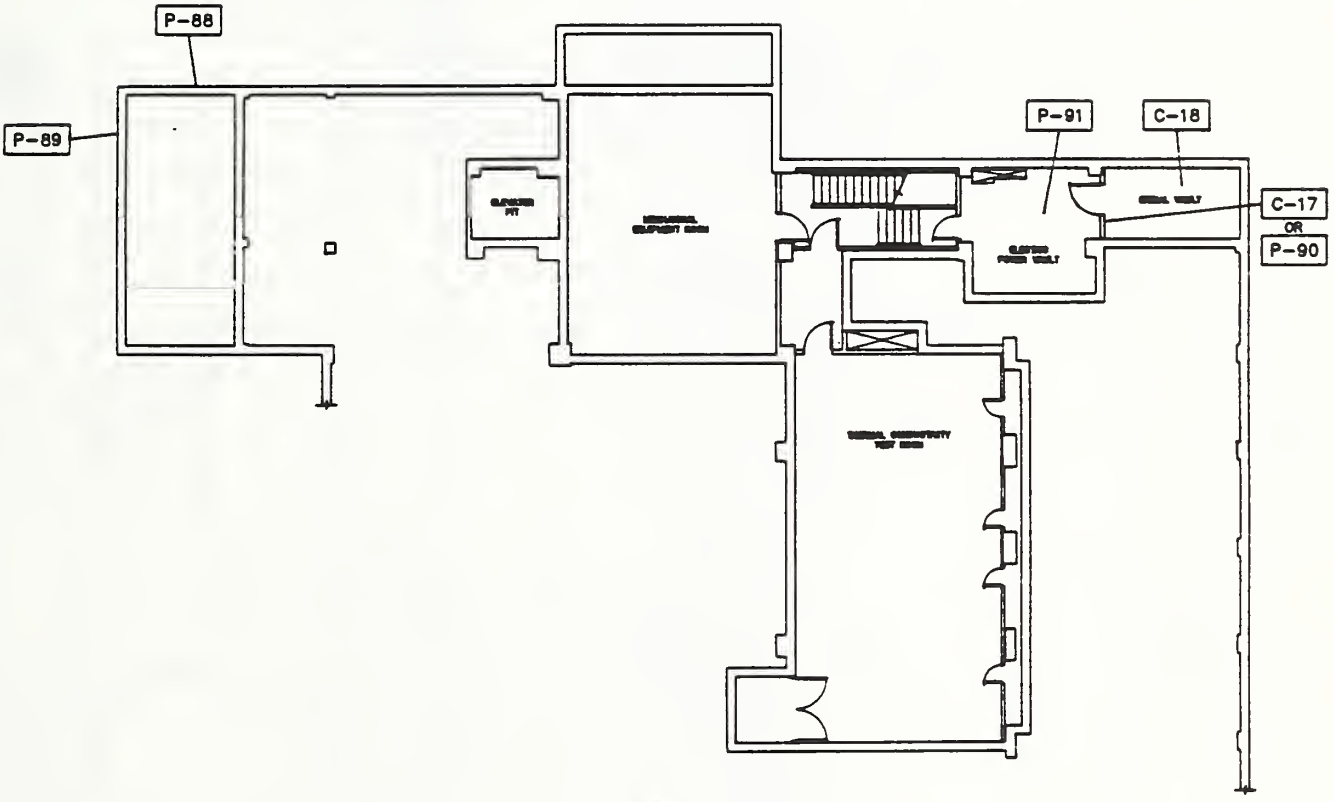
BUILDING 225 – ATTIC FLOOR



PLAN OF COVERED WALK

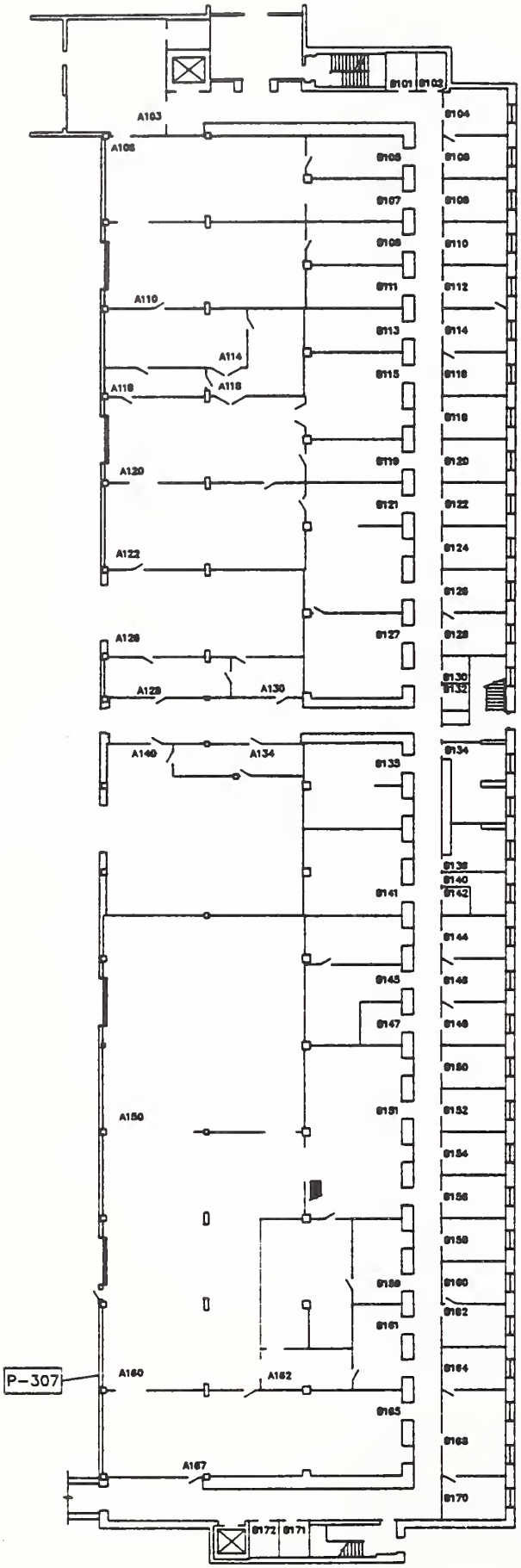
BETWEEN ADMIN. AND BLDG. 225

FIGURE 28



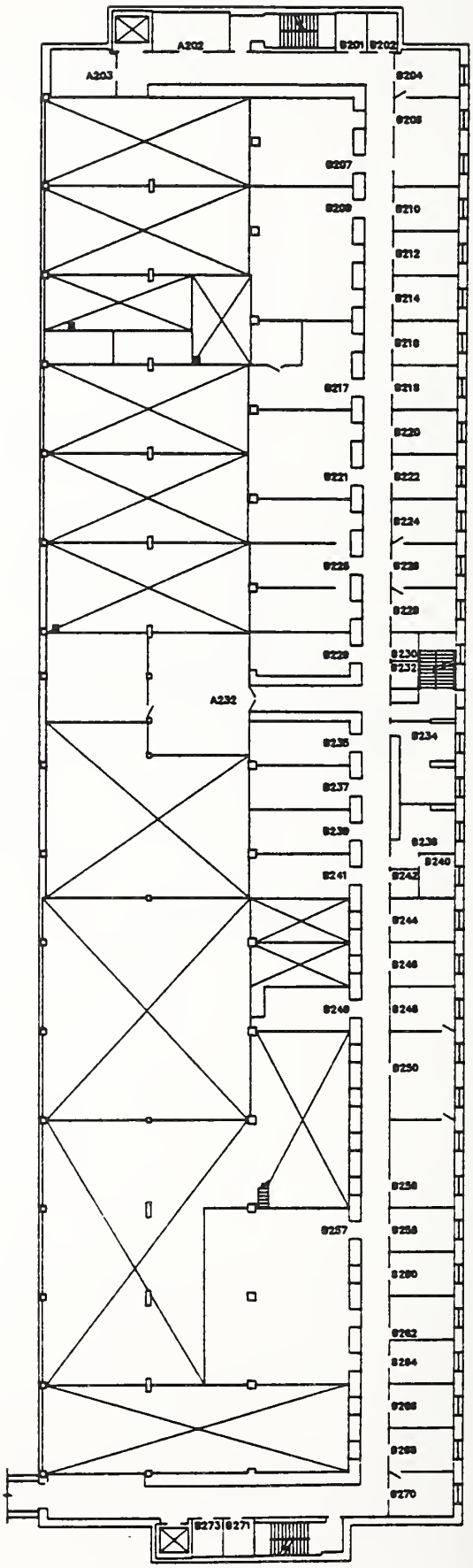
BLDG. 228 - BASEMENT
CORE 1

FIGURE 29



BUILDING 226 – FIRST FLOOR

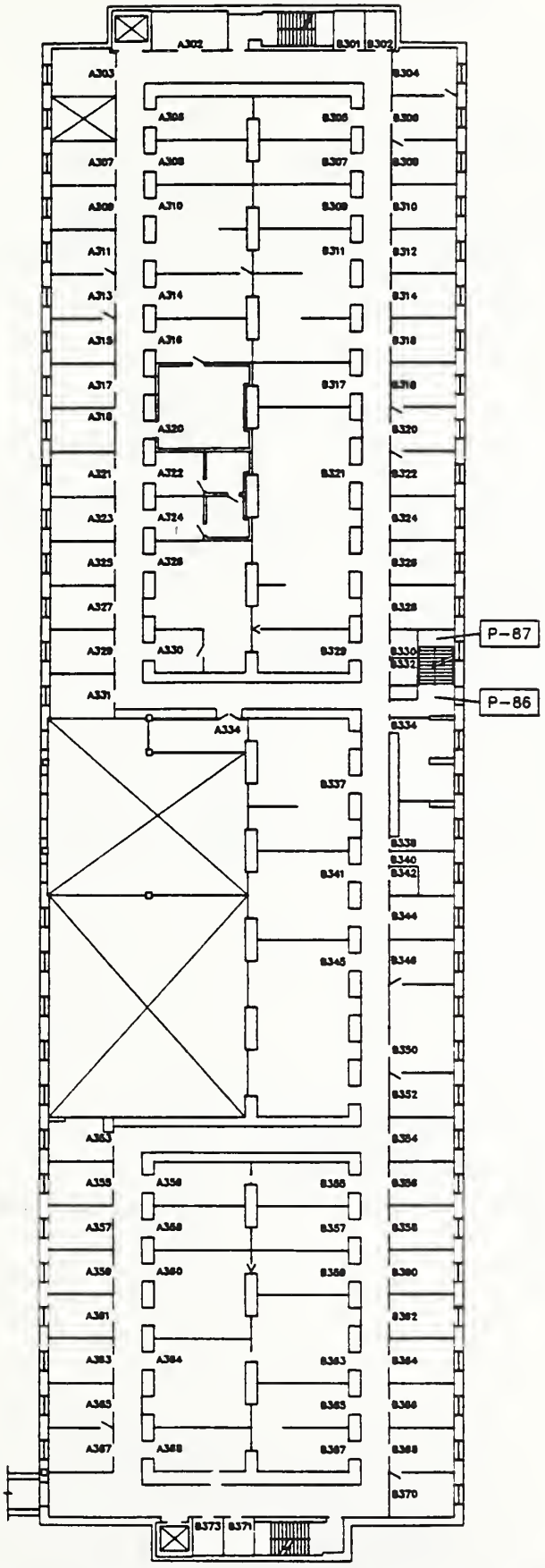
DATE OF LAST REVISION: 11/14/90



BUILDING 226 – SECOND FLOOR

DATE OF LAST REVISION: 11/14/90

FIGURE 30



BUILDING 226 – THIRD FLOOR

DATE OF LAST REVISION: 11/14/90

FIGURE 31

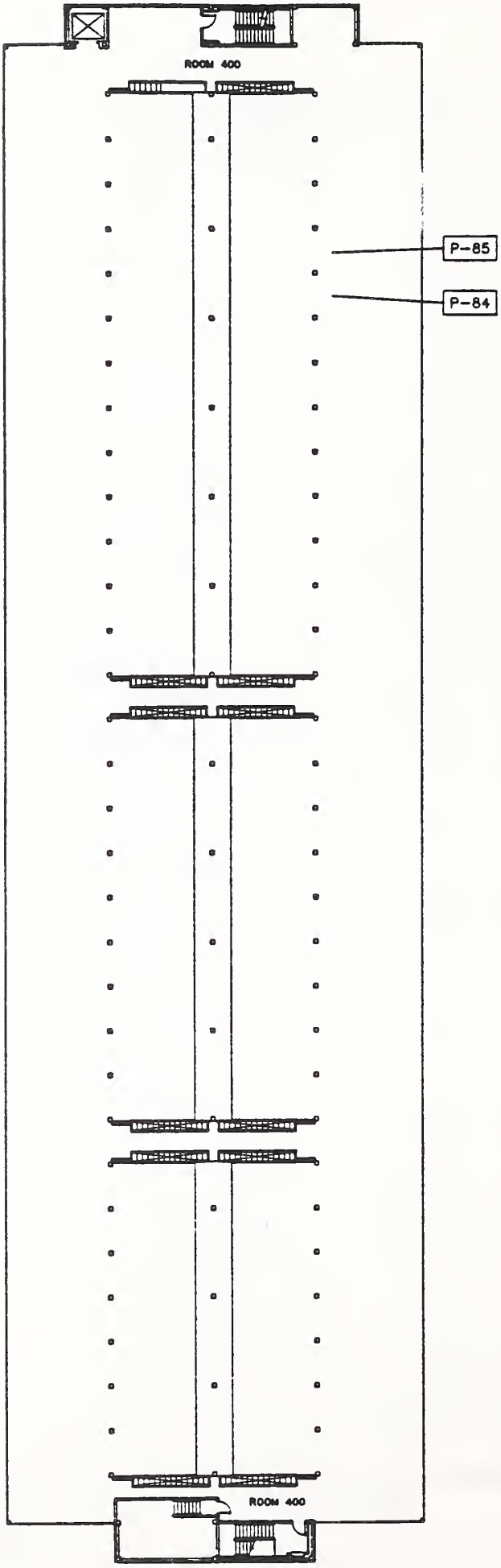
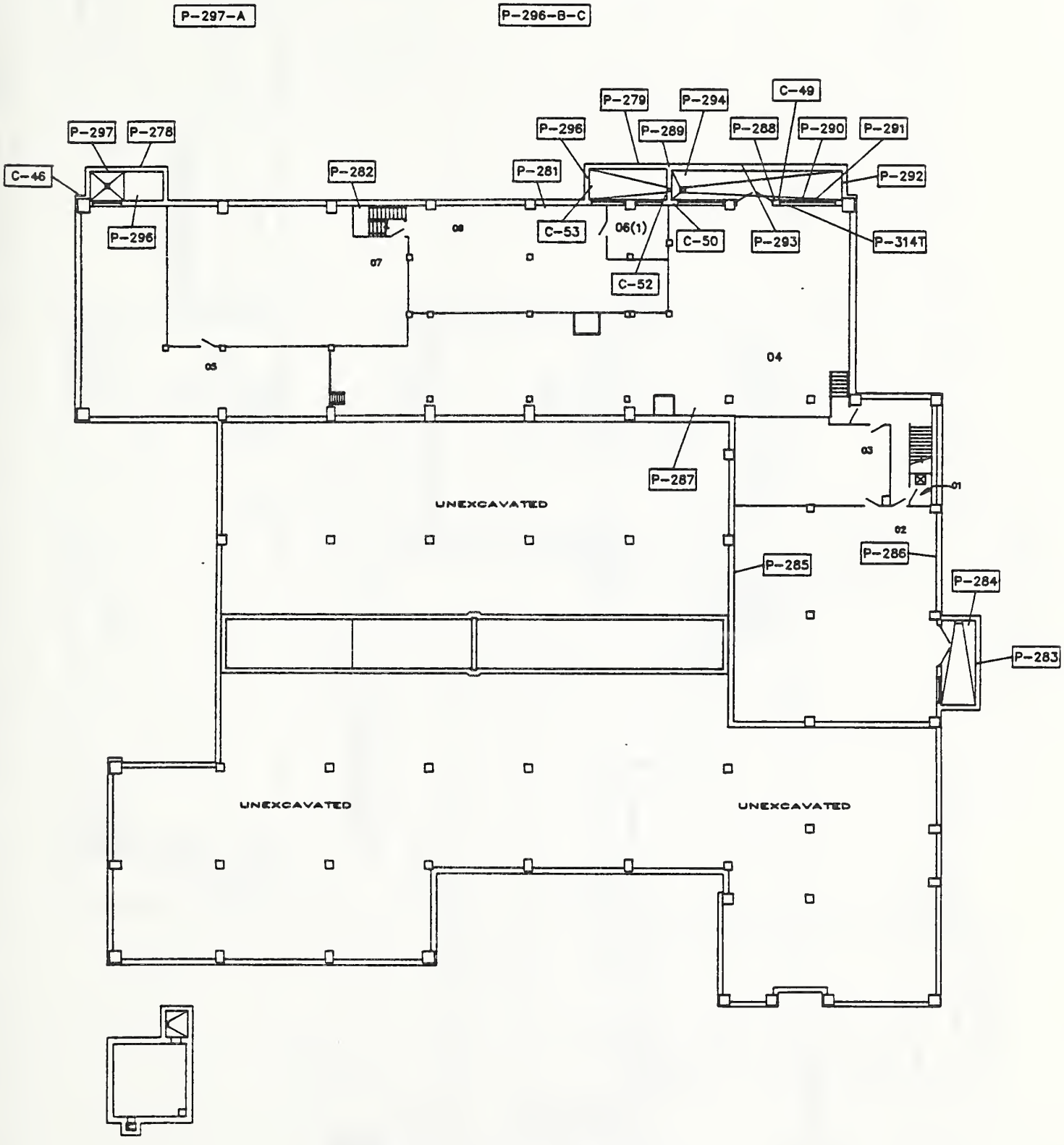


FIGURE 32

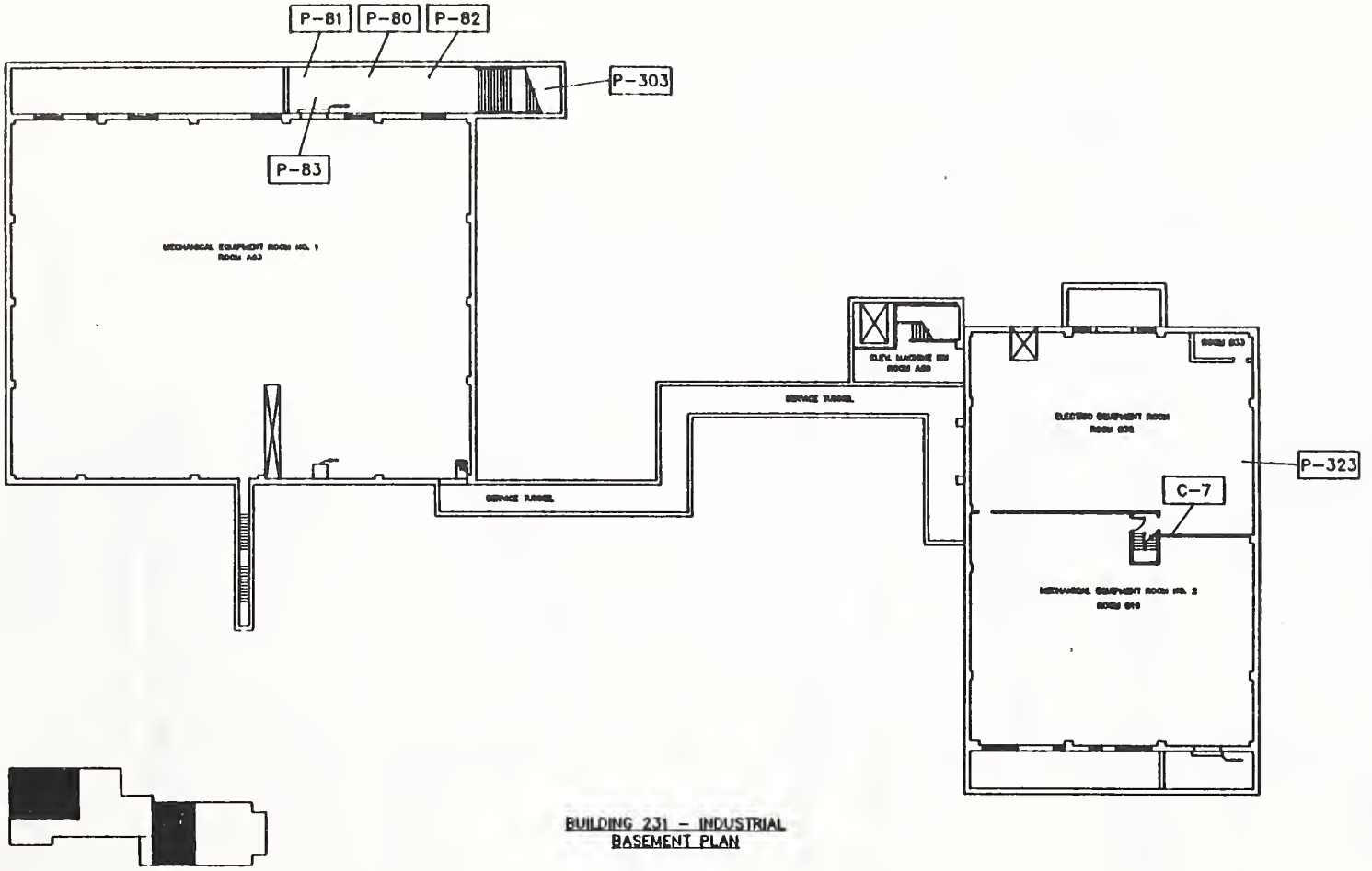
BUILDING 226 – ATTIC FLOOR



BUILDING 230 – BASEMENT FLOOR

DATE OF LAST REVISION: 11/14/90

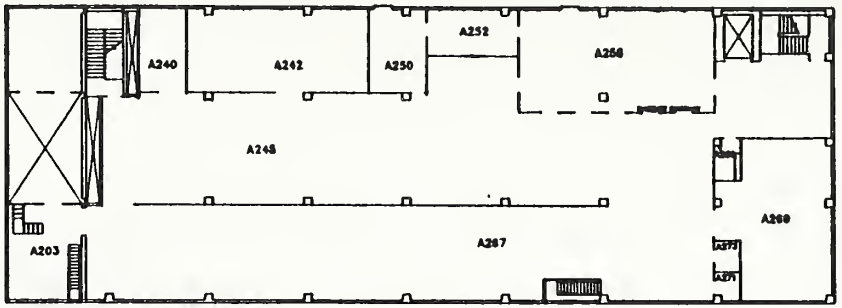
FIGURE 33



BUILDING 231 – INDUSTRIAL
BASEMENT PLAN

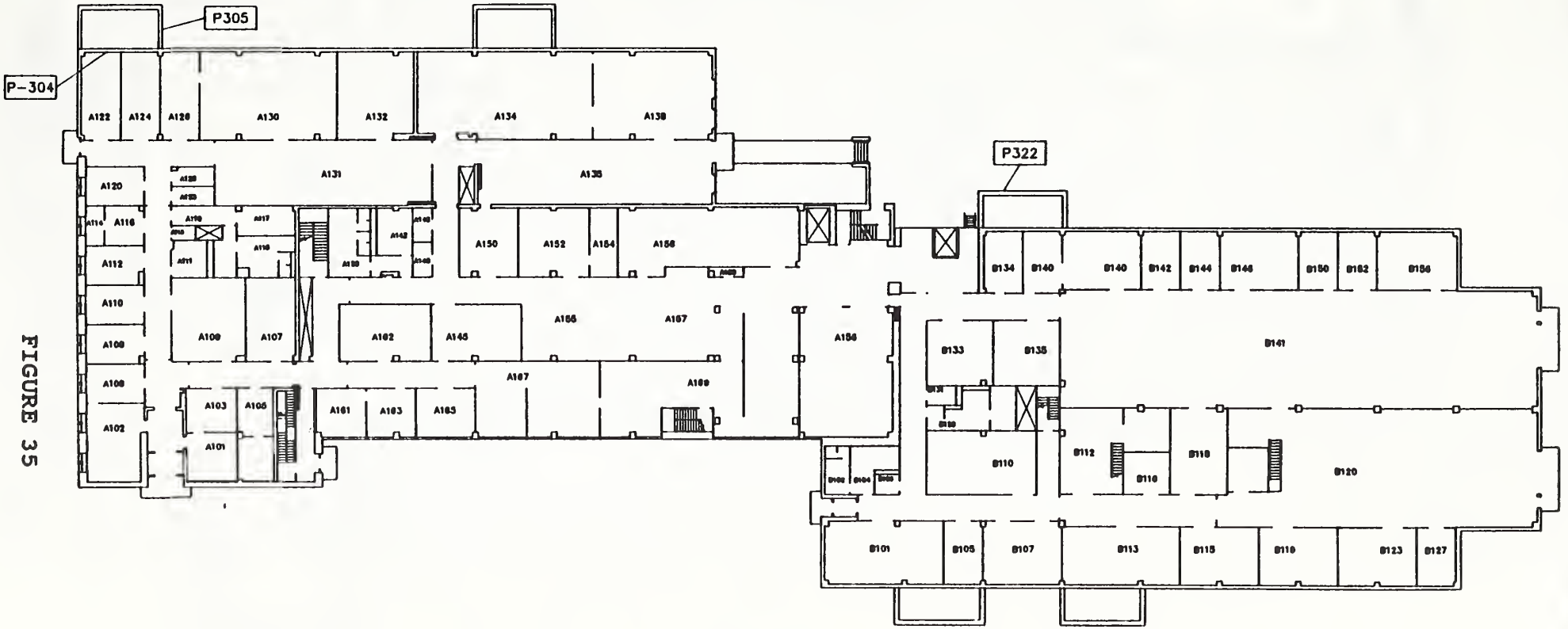
BUILDING 231 – INDUSTRIAL
MONITOR FLOOR

FIGURE 34



BUILDING 231 – SECOND FLOOR

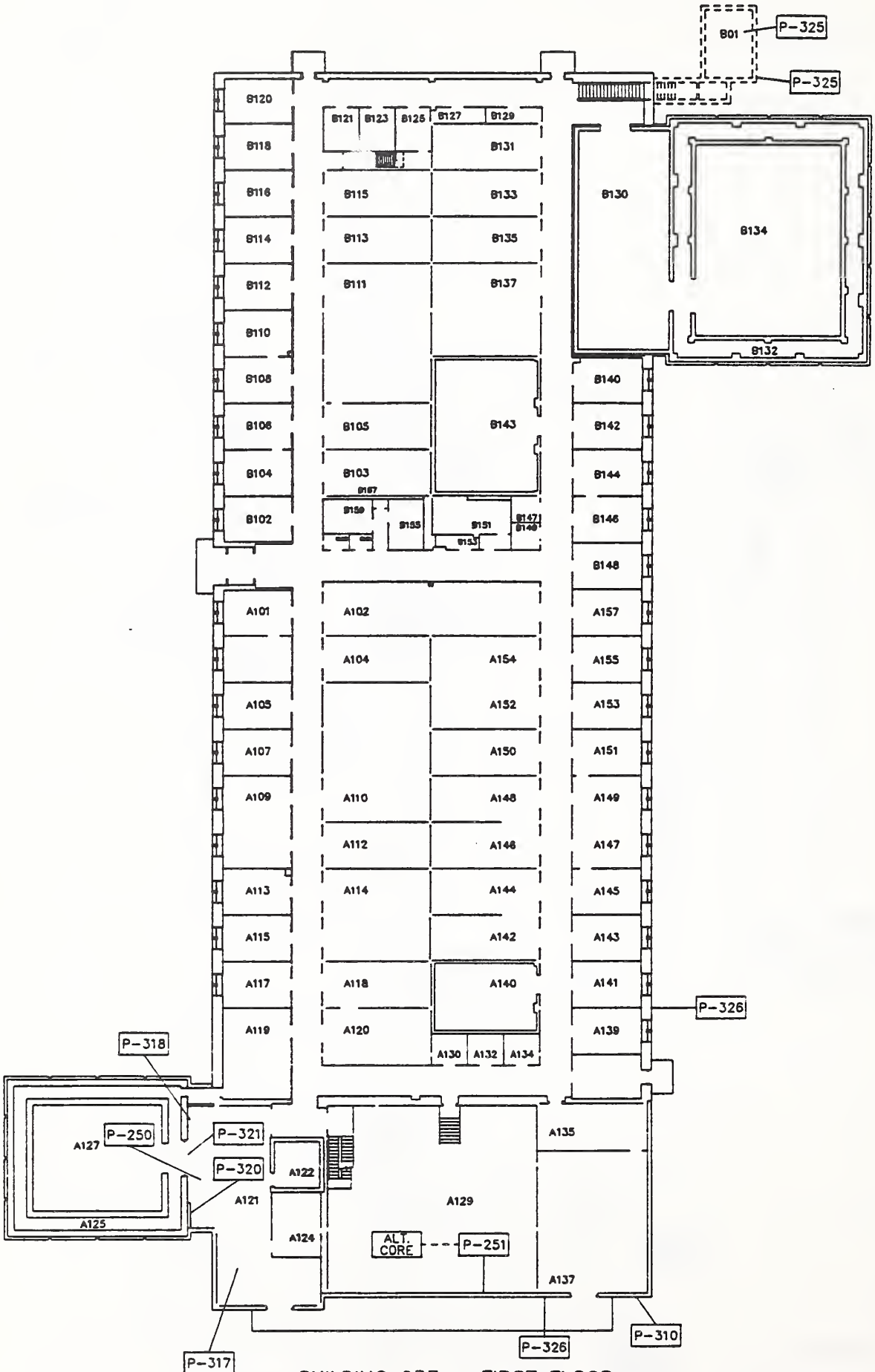
DATE OF LAST REVISION: 11/14/90



BUILDING 231 – FIRST FLOOR

DATE OF LAST REVISION: 11/14/90

FIGURE 35



BUILDING 233 – FIRST FLOOR

FIGURE 36

DATE OF LAST REVISION: 11/14/90

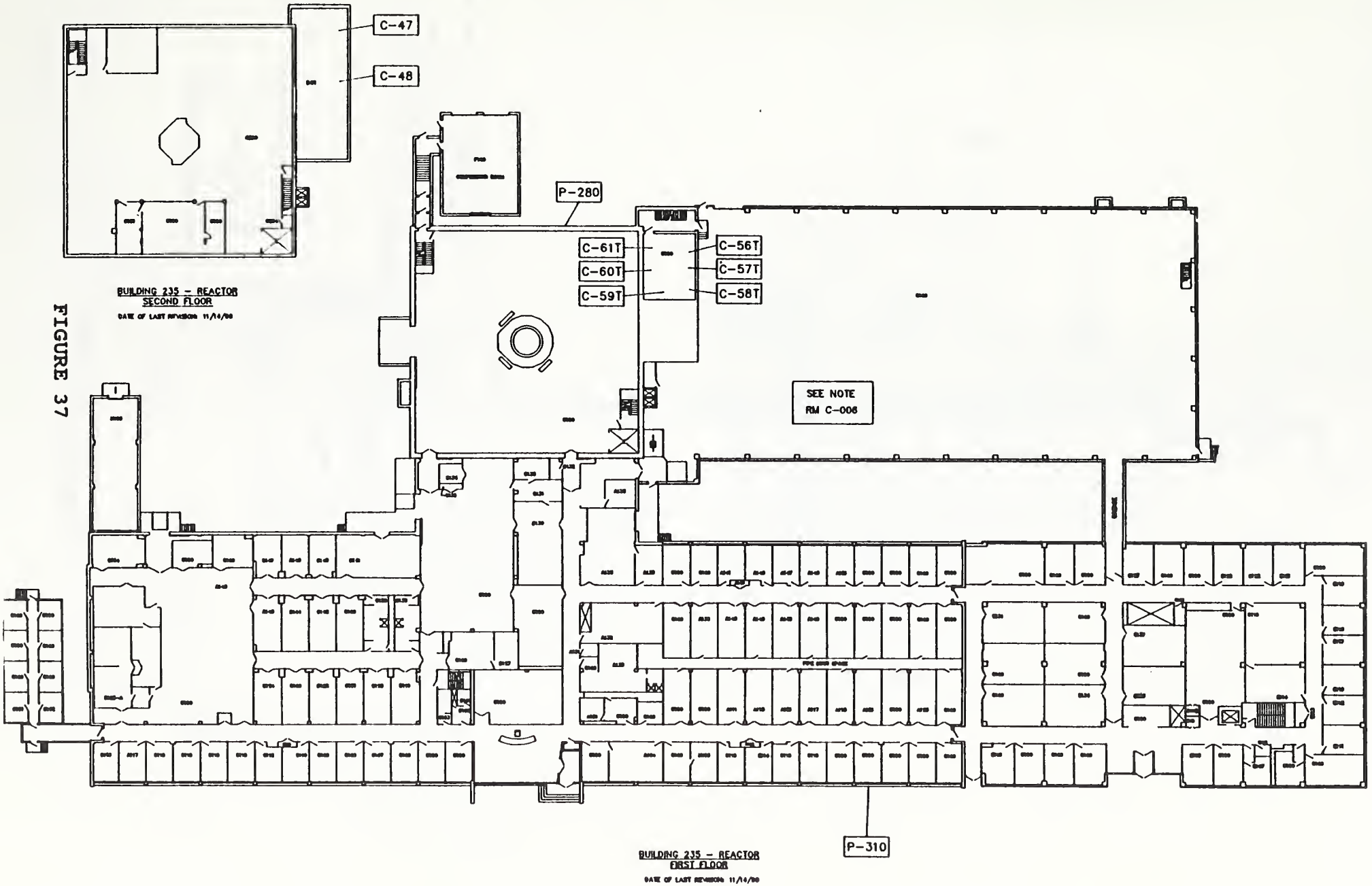

C-47
C-48
P-280
C-61T
C-60T
C-59T
C-56T
C-57T
C-58T
SEE NOTE
RM C-006
P-310
BUILDING 235 - REACTOR
SECOND FLOOR
DATE OF LAST REVISION 11/14/90
BUILDING 235 - REACTOR
FIRST FLOOR
DATE OF LAST REVISION 11/14/90

FIGURE 37

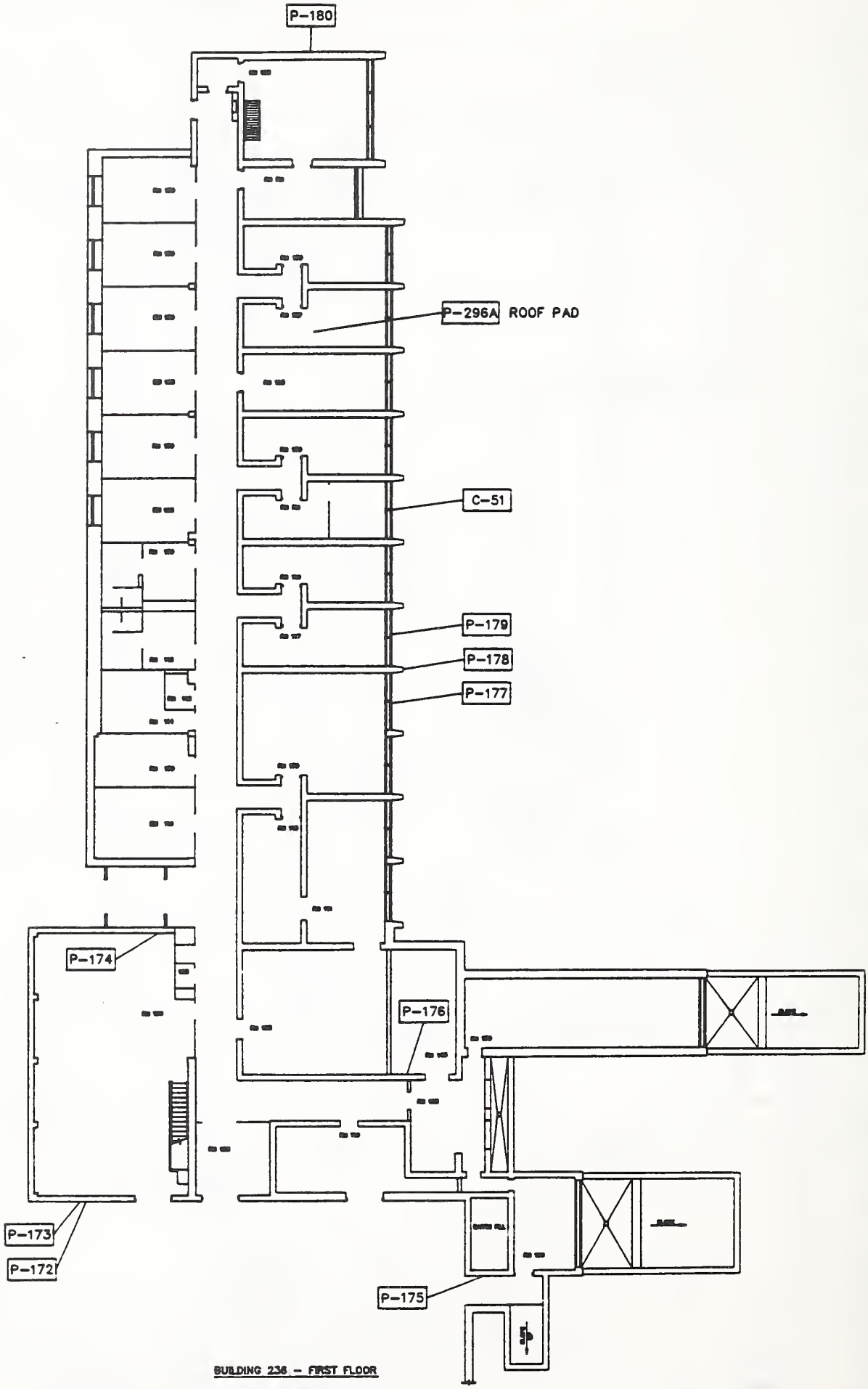
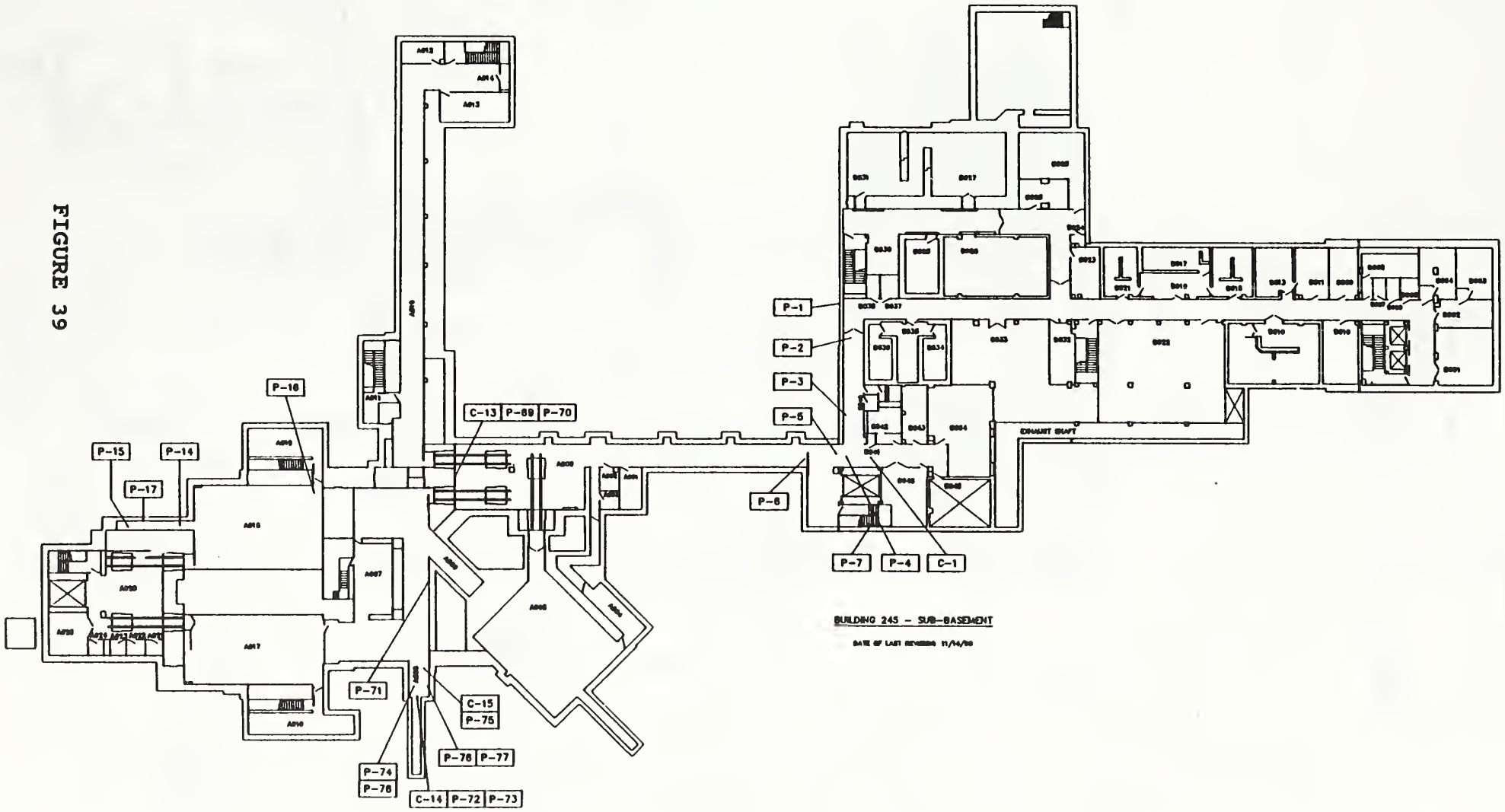

P-180
P-296A ROOF PAD
C-51
P-179
P-178
P-177
P-174
P-176
P-173
P-172
P-175
BUILDING 236 - FIRST FLOOR

FIGURE 38

FIGURE 39


P-1
P-2
P-3
P-5
P-6
P-7
P-4
C-1
P-10
P-15
P-14
P-17
C-13
P-69
P-70
P-71
C-15
P-75
P-78
P-77
P-74
P-76
C-14
P-72
P-73
EXHAUST SHAFT
BUILDING 245 - SUB-BASEMENT

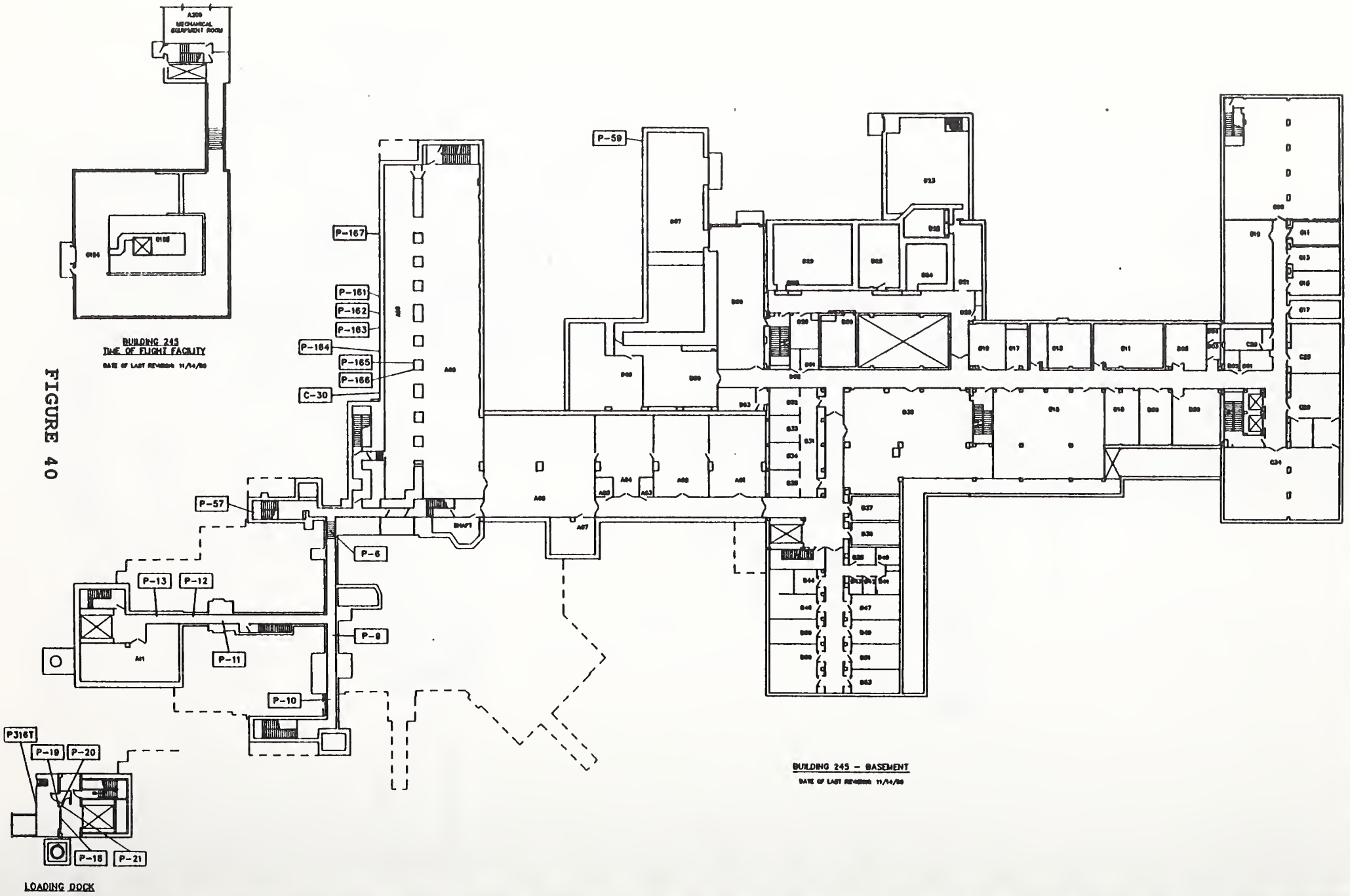
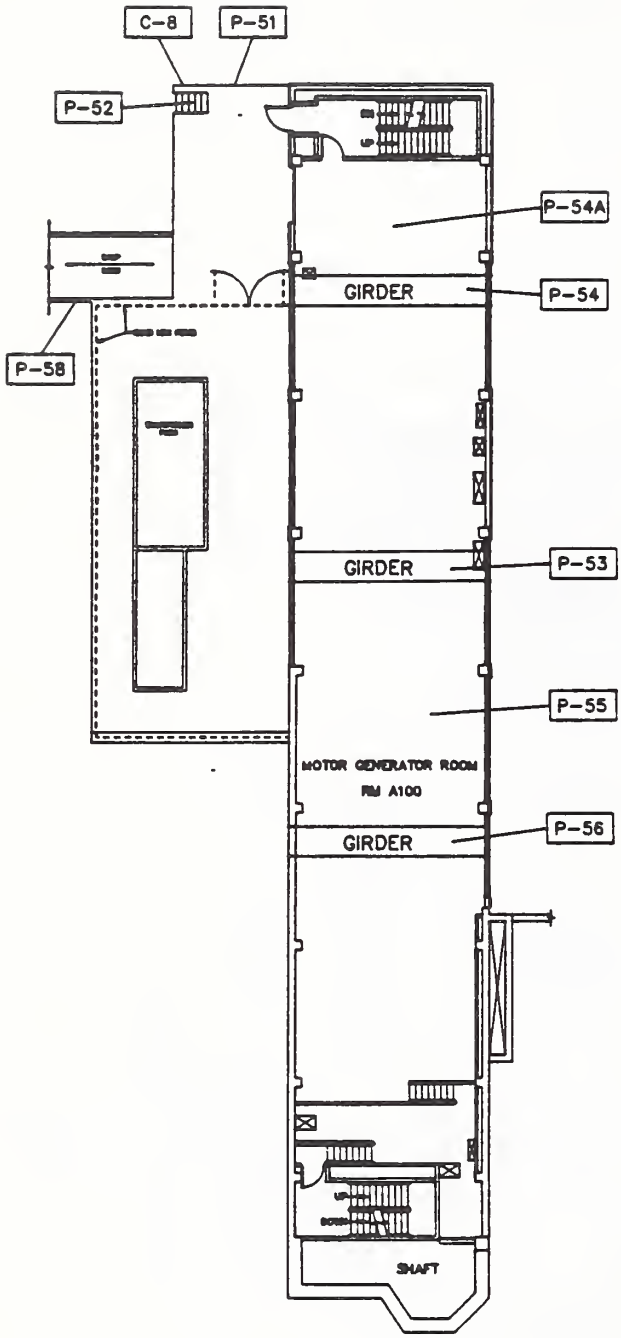

A309
MECHANICAL EQUIPMENT ROOM
BUILDING 245
TIME OF FLIGHT FACILITY
DATE OF LAST REVISION 11/14/88
P-167
P-161
P-162
P-163
P-164
P-165
P-166
C-30
P-59
P-57
P-6
P-13
P-12
P-9
P-11
P-10
P316T
P-19
P-20
P-18
P-21
LOADING DOCK
BUILDING 245 - BASEMENT
DATE OF LAST REVISION 11/14/88

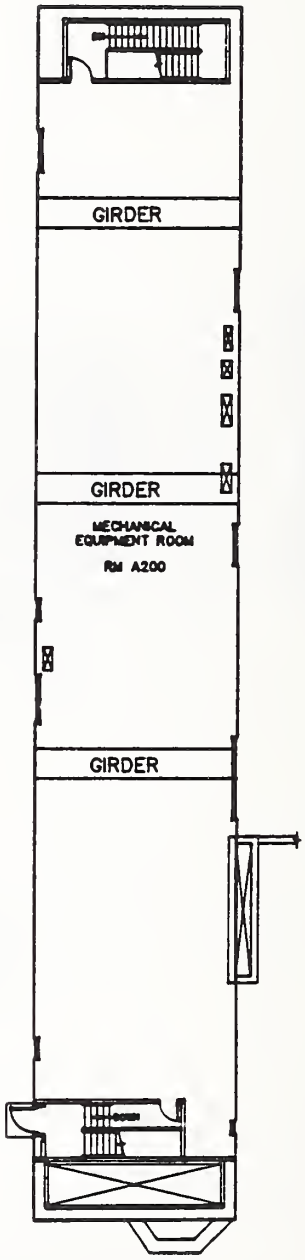
FIGURE 40

SOLIDS SEPARATOR FACILITY
P-02
P-03
C-10
C-11
P-04
P-06
P-07
C-9
C-12
P-01
P-05
P-63
P-00
P-60

FIGURE 41

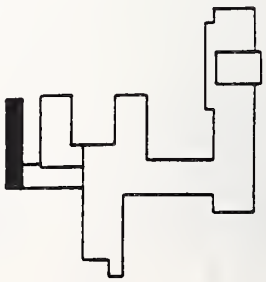


MOTOR GENERATOR ROOM
BLDG. 245 – RADIATION PHYSICS



MECHANICAL EQUIPMENT ROOM
BLDG. 245 – RADIATION PHYSICS

FIGURE 42



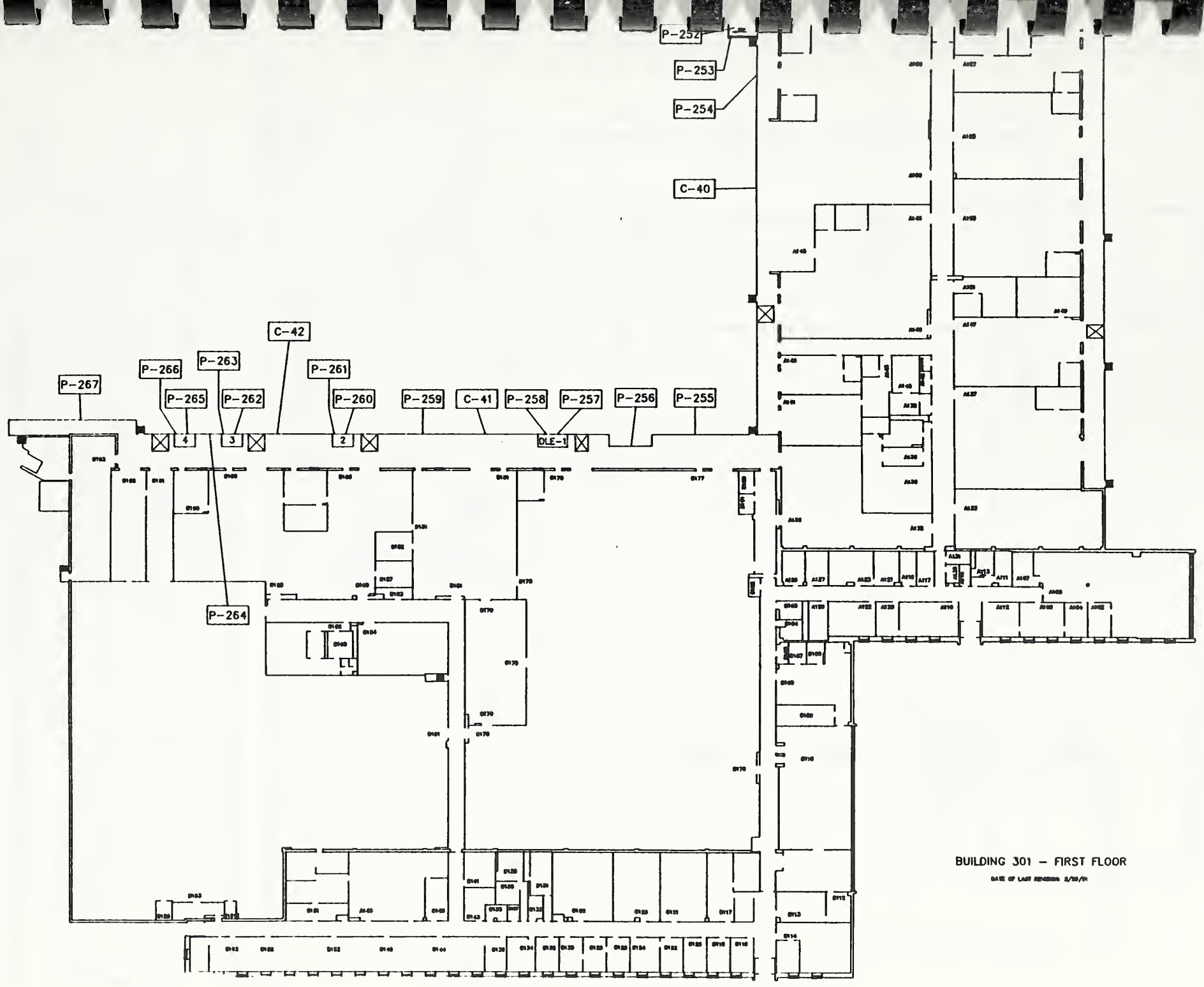

P-252
P-253
P-254
C-40
C-42
P-267
P-266
P-263
P-261
P-265
P-262
P-260
P-259
C-41
P-258
P-257
P-256
P-255
4
3
2
DLE-1
P-264
BUILDING 301 – FIRST FLOOR

FIGURE 43

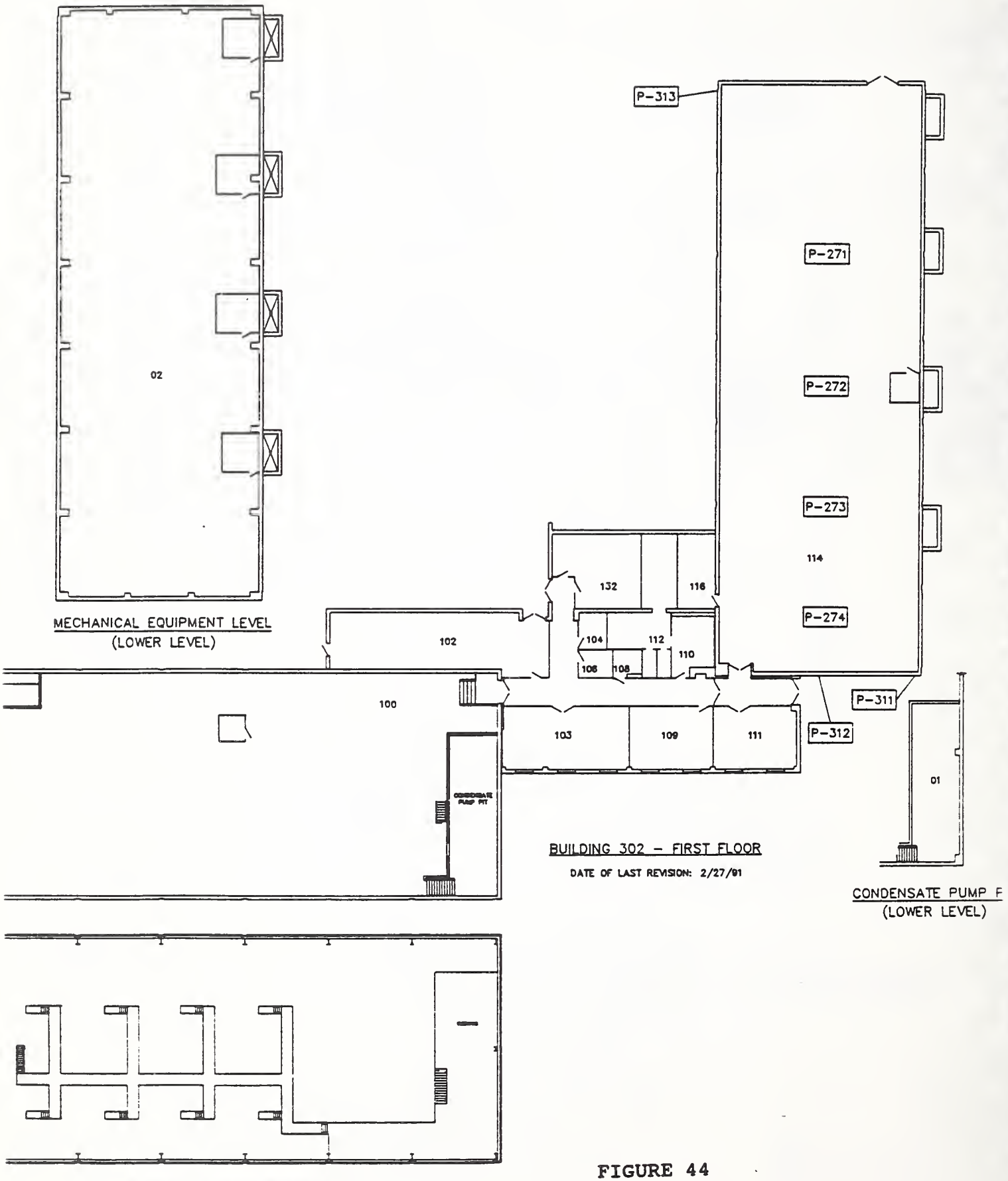
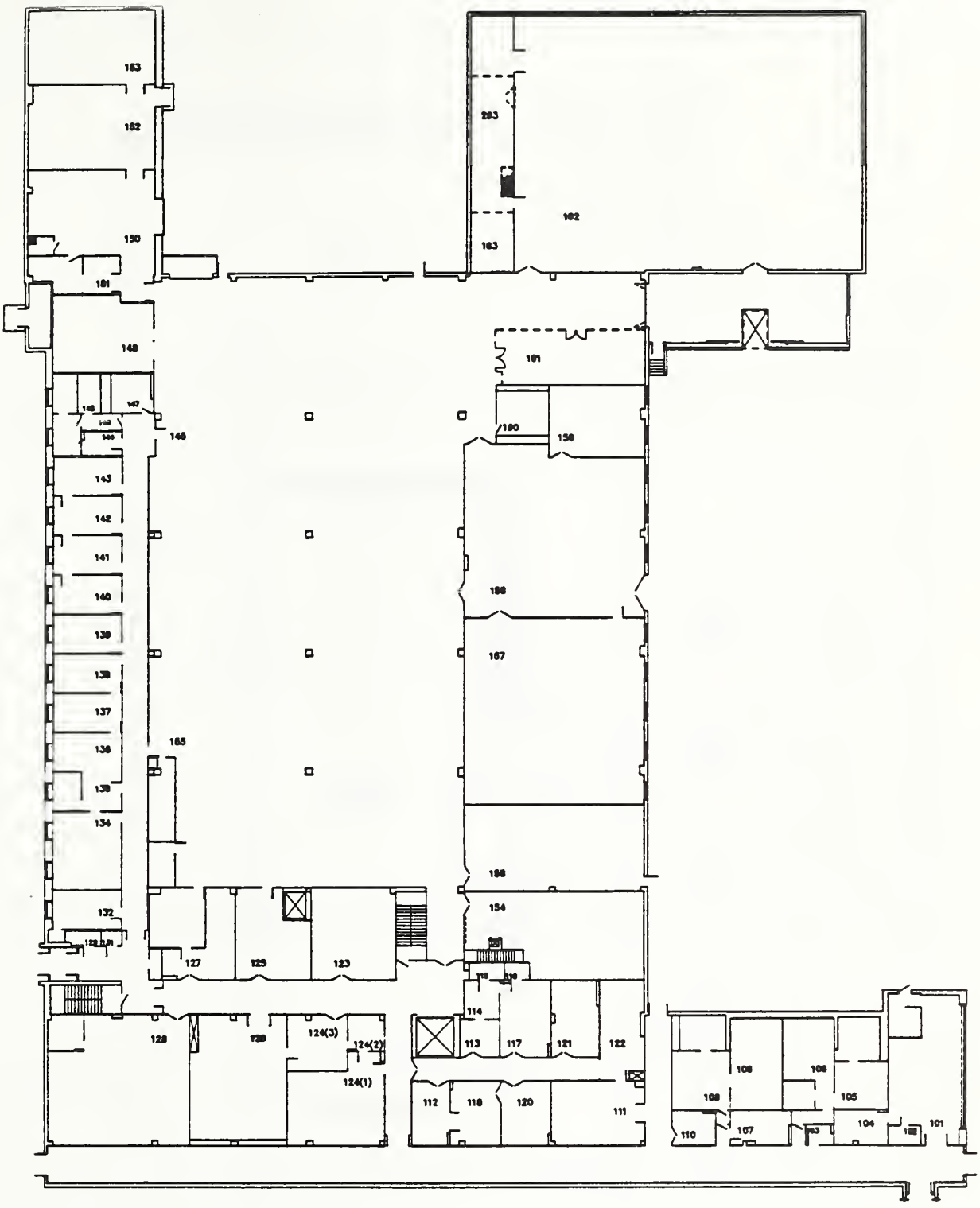
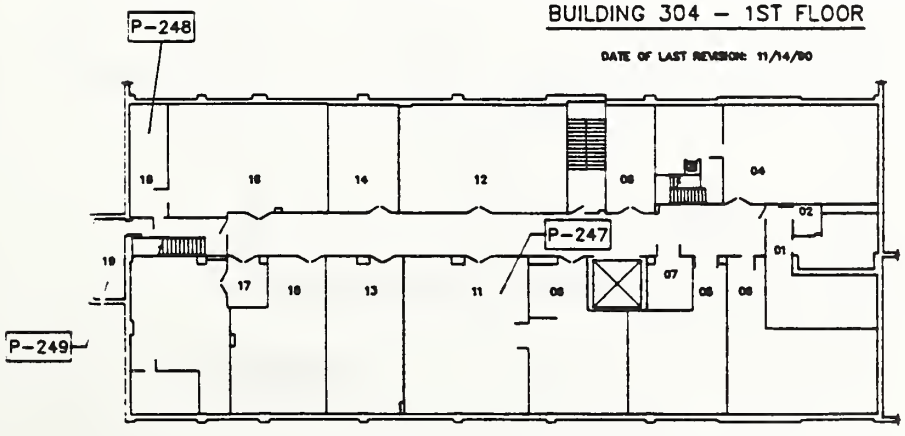

P-313
P-271
P-272
P-273
P-274
P-311
P-312
02
114
132
116
102
104
112
110
106
108
100
103
109
111
01
MECHANICAL EQUIPMENT LEVEL
(LOWER LEVEL)
BUILDING 302 - FIRST FLOOR
DATE OF LAST REVISION: 2/27/91
CONDENSATE PUMP F
(LOWER LEVEL)

FIGURE 44



BUILDING 304 – 1ST FLOOR

DATE OF LAST REVISION: 11/14/90



BUILDING 304 – BASEMENT FLOOR

DATE OF LAST REVISION: 11/14/90

FIGURE 45

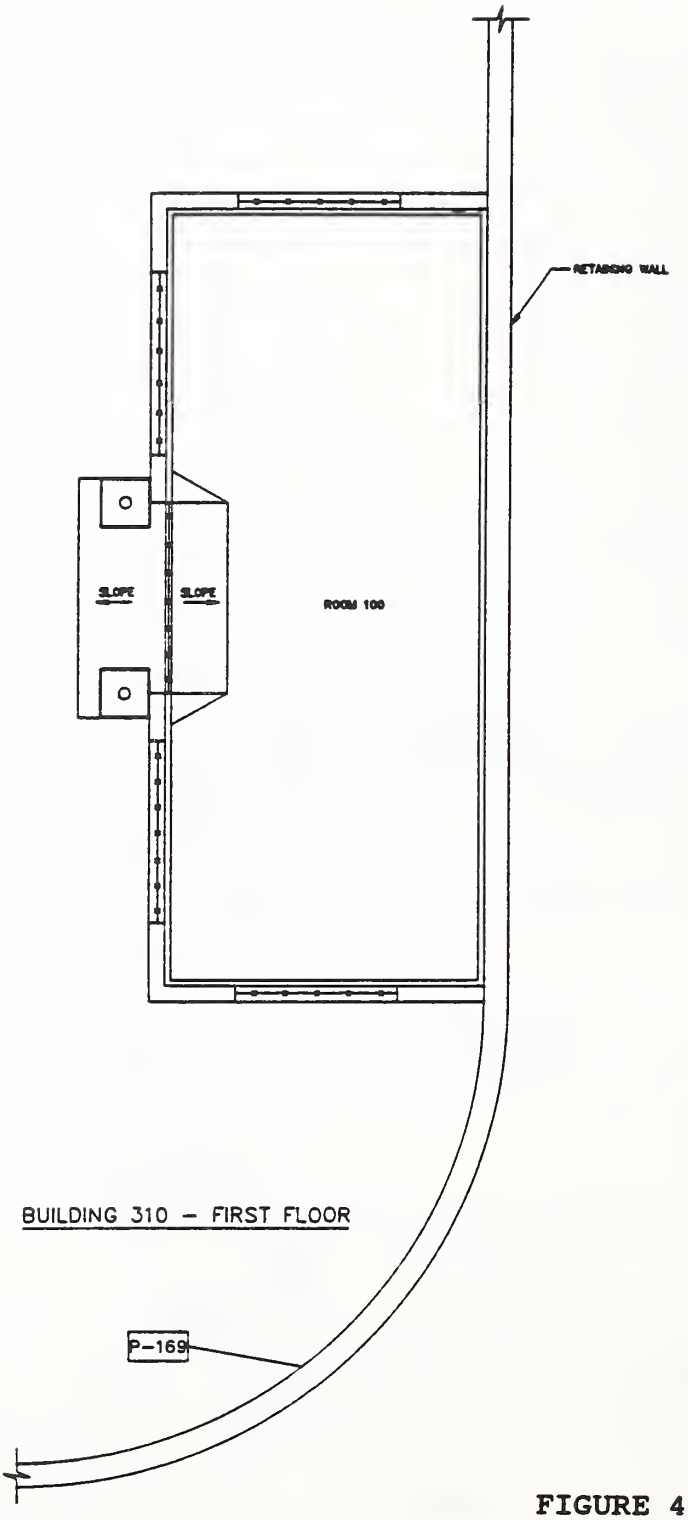
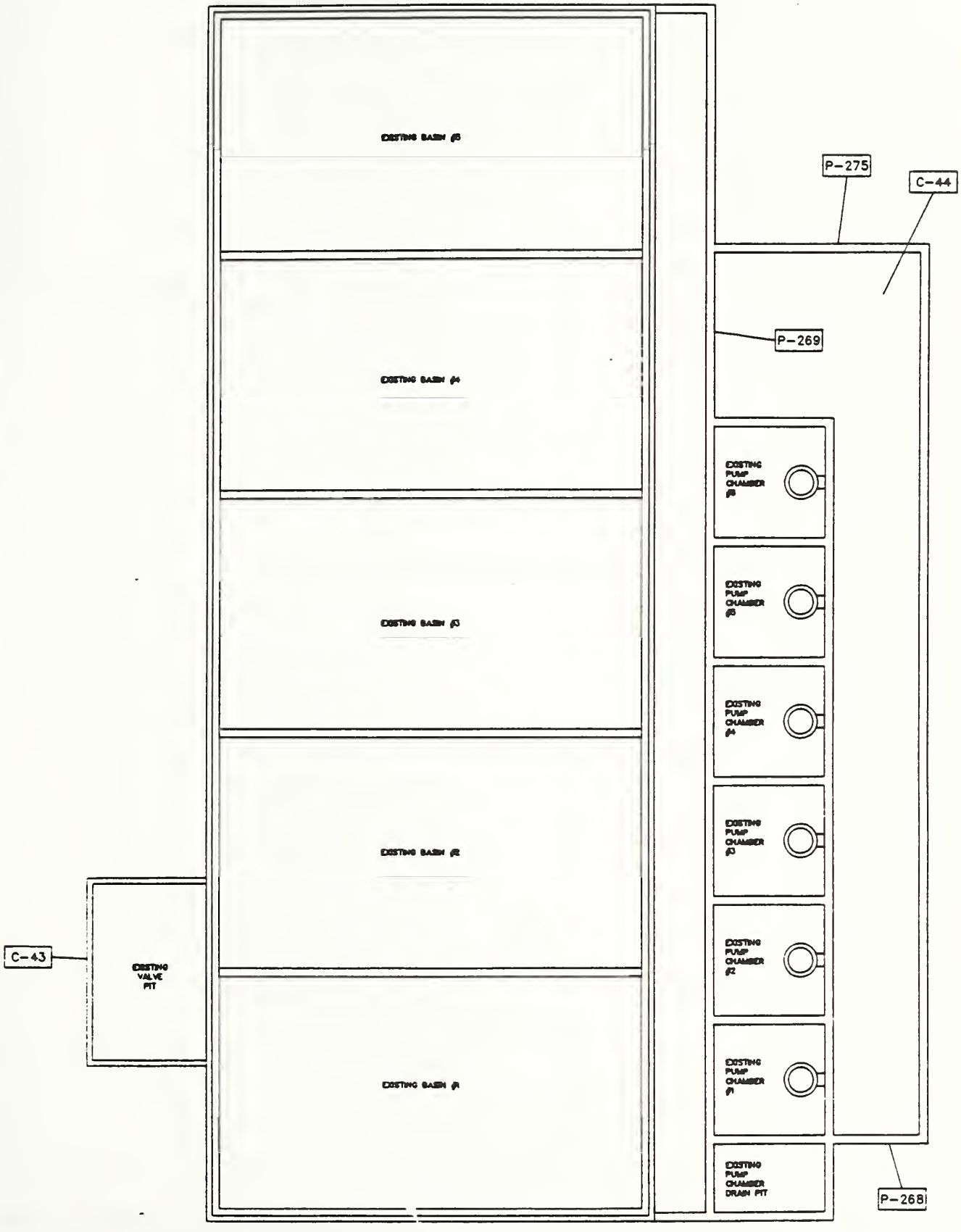
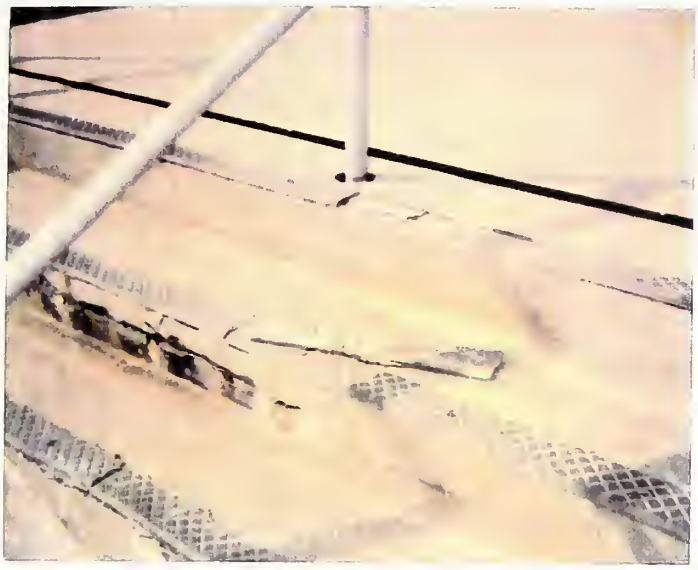

RETAINING WALL
SLOPE
SLOPE
ROOM 100
BUILDING 310 – FIRST FLOOR
P-169

FIGURE 46

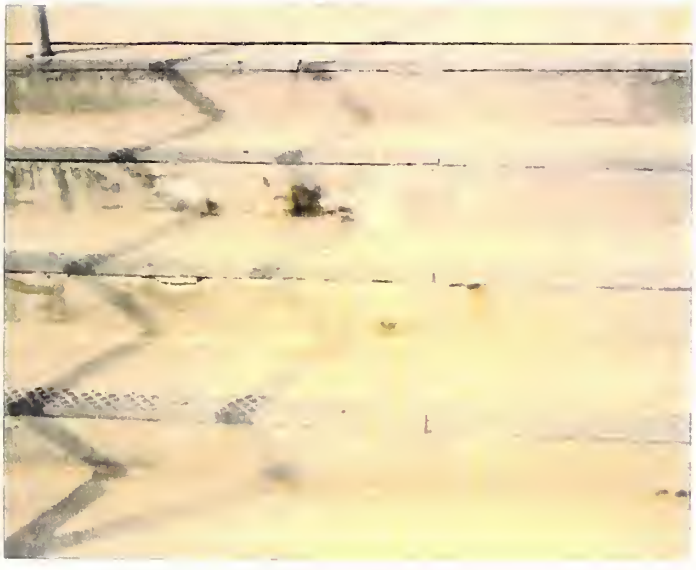


COOLING TOWER **FIGURE 47**

Figures 48 to 76: Examples of Distress in Buildings and Related Structures



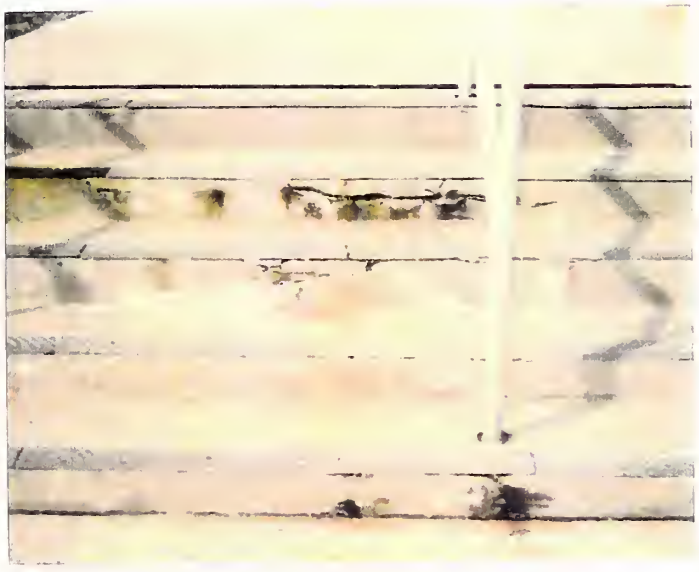
BUILDING 205 – FRONT STAIRS



BUILDING 205 – FRONT STAIRS

FIGURE 48

BUILDING 205 - FRONT STAIRS



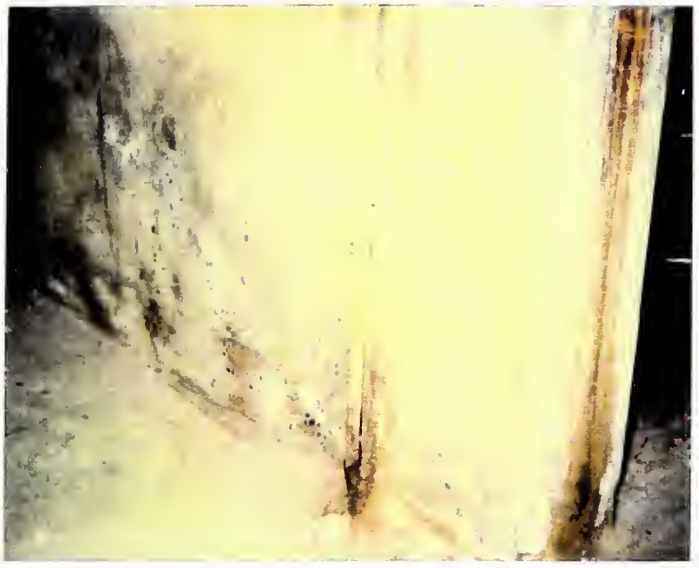
BUILDING 205 - FRONT STAIRS

FIGURE 49

BUILDING 206 - STORAGE BINS ROOF

BUILDING 206 - STORAGE BINS ROOF

FIGURE 50



BUILDING 206 - STORAGE BINS

BUILDING 206 - STORAGE BINS

FIGURE 51

BUILDING 206 – STORAGE BINS

BUILDING 206 – STORAGE BINS

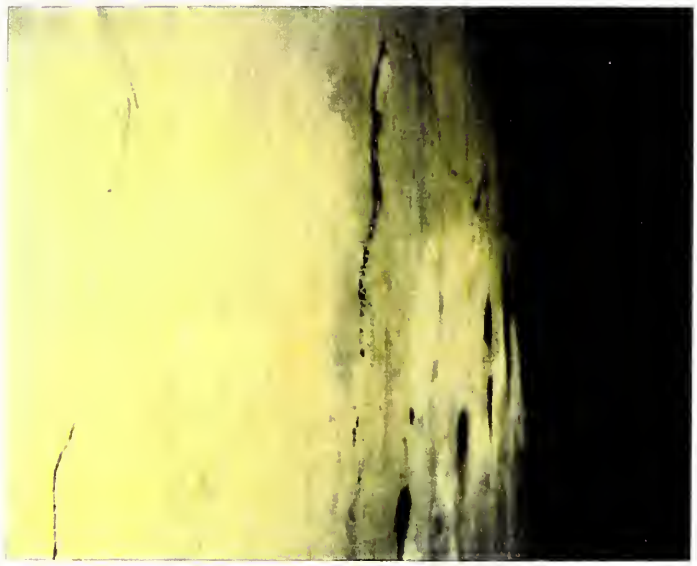
FIGURE 52

BUILDING 206 - STORAGE BINS

BUILDING 206 - STORAGE BINS

FIGURE 53

BUILDING 206 - TOP STORAGE BINS



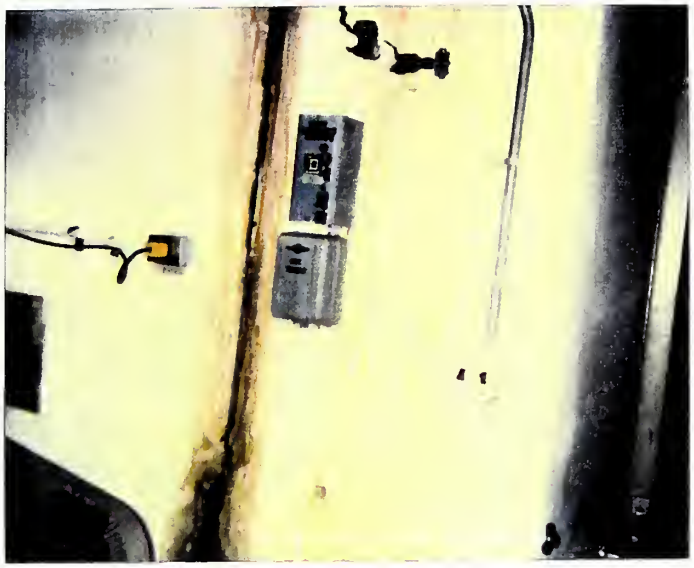
BUILDING 206 - TOP STORAGE BINS

FIGURE 54

BUILDING 206 - TOP STORAGE BINS

BUILDING 206 - TOP STORAGE BINS

FIGURE 55



BUILDING 220 – MECHANICAL ROOM
EXPANSION JOINT

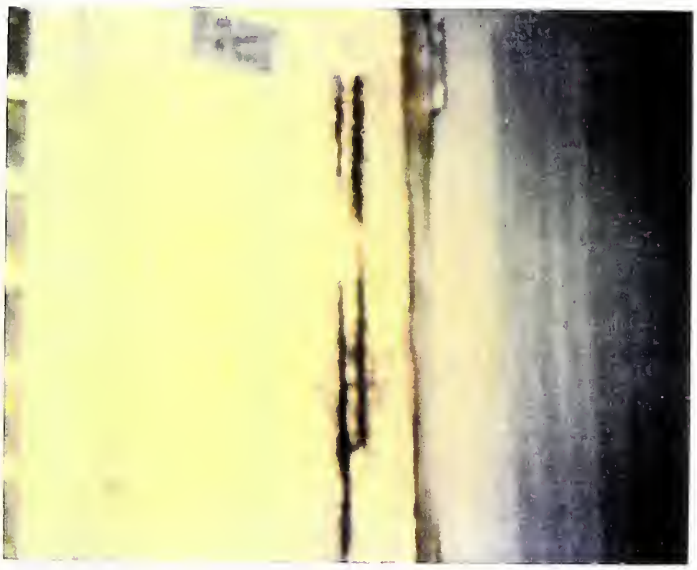
FIGURE 56

BUILDING 226 - TRANSFORMER ROOM

BUILDING 226 - TRANSFORMER ROOM

FIGURE 57

BUILDING 230, NORTHWEST PIT



BUILDING 230, NORTHWEST PIT

FIGURE 58

BUILDING 233 ROOF SLAB, ROOM A121

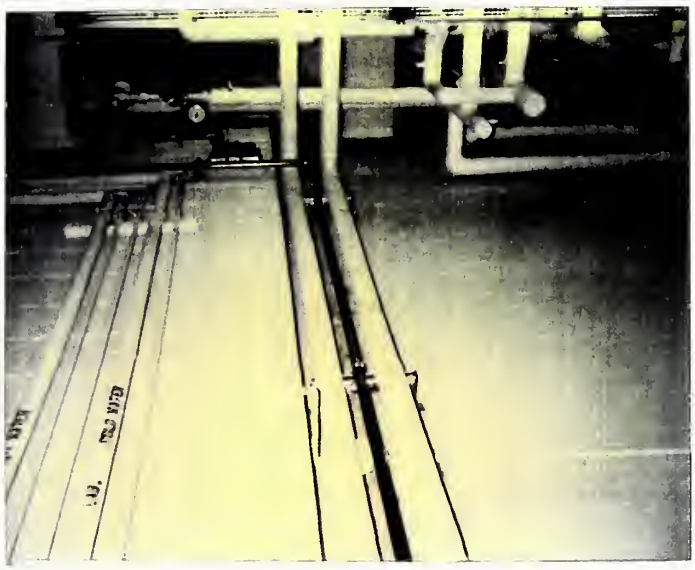
BUILDING 233 ROOF SLAB, ROOM A121

FIGURE 59

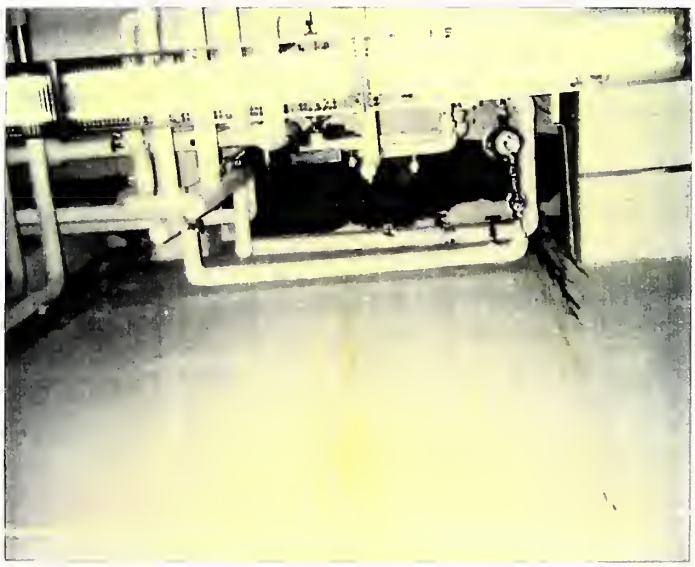
BUILDING 233 ROOF SLAB, ROOM A121

BUILDING 233 ROOF SLAB, ROOM A121

FIGURE 60



BUILDING 233 ROOF SLAB, ROOM A121
(AFTER REMOVAL OF DELAMINATED CONCRETE)



BUILDING 233 ROOF SLAB, ROOM A121
(AFTER REMOVAL OF DELAMINATED CONCRETE)

FIGURE 61

BUILDING 233 ROOF SLAB, ROOM A121
(AFTER REMOVAL OF DELAMINATED CONCRETE)

FIGURE 62

BUILDING 235 ROOM C006

BUILDING 235 ROOM C006

FIGURE 63

BUILDING 235, WEST WALL

FIGURE 64

BUILDING 236 - NORTH WALL

BUILDING 236 - NORTH WALL

FIGURE 65

BUILDING 245 - BASEMENT, ROOM A10

BUILDING 245 - BASEMENT, ROOM A10

FIGURE 66

BUILDING 245 - BASEMENT, ROOM A10

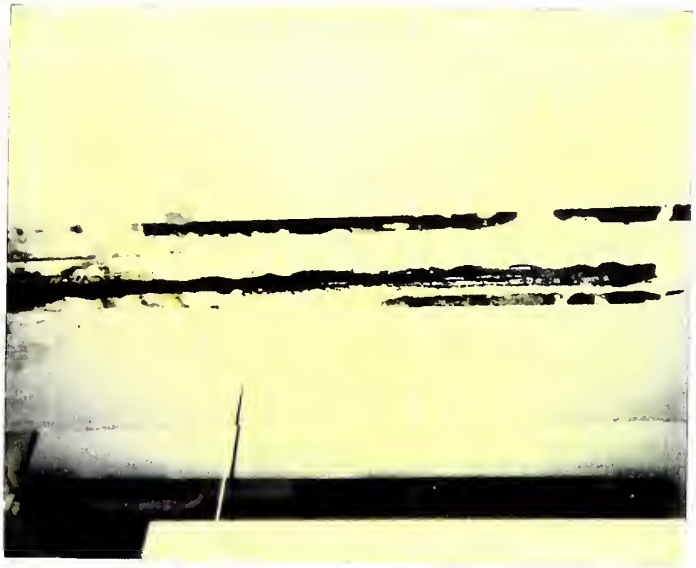
FIGURE 67

BUILDING 245 – SUBBASEMENT EXPANSION JOINT

BUILDING 245 – SUBBASEMENT EXPANSION JOINT

FIGURE 68

BUILDING 245 - SUBBASEMENT EXPANSION JOINT



BUILDING 245 - SUBBASEMENT EXPANSION JOINT

FIGURE 69

BUILDING 245 - SUBBASEMENT, ROOM A008

BUILDING 245 - SUBBASEMENT, ROOM A007

FIGURE 70

BUILDING 245 - SUBBASEMENT, ROOM AO08

BUILDING 245 - SUBBASEMENT, ROOM A008

FIGURE 71

BUILDING 245 - EAST LOADING DOCK

BUILDING 245 - EAST LOADING DOCK

FIGURE 72

BUILDING 245 – EAST LOADING DOCK

BUILDING 245 - EAST LOADING DOCK

FIGURE 73

BUILDING 245 - SOUTHEAST LOADING DOCK

BUILDING 245 - SOUTHEAST LOADING DOCK

FIGURE 74

BUILDING 245 - SOUTHWEST LOADING DOCK

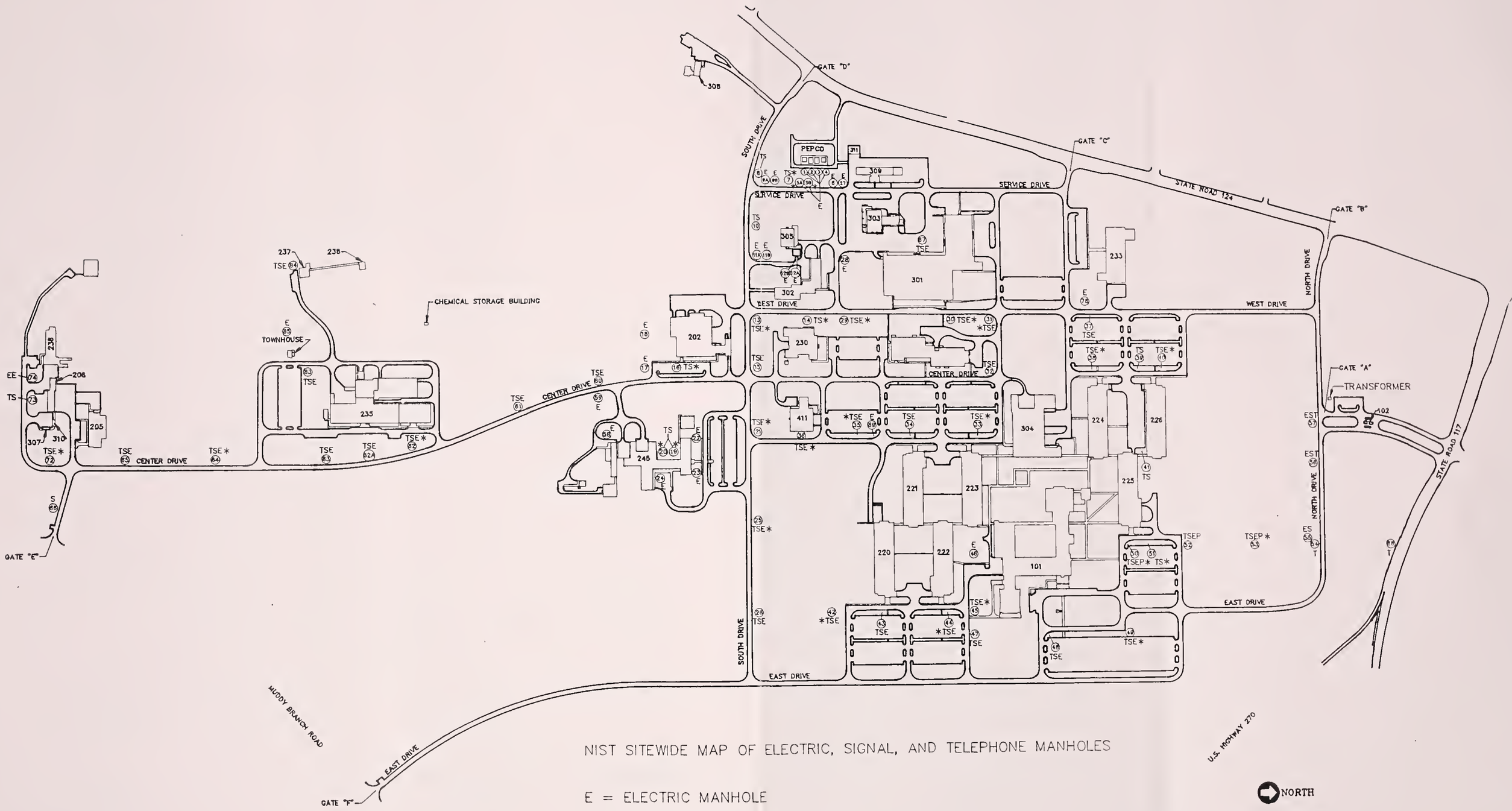
BUILDING 245 - SOUTHWEST LOADING DOCK

FIGURE 75

BUILDING 245 - WEST EXTERIOR FOUNDATION WALL

BUILDING 245 - WEST EXTERIOR FOUNDATION WALL

FIGURE 76



NIST SITEWIDE MAP OF ELECTRIC, SIGNAL, AND TELEPHONE MANHOLES

E = ELECTRIC MANHOLE

S = SIGNAL MANHOLE

T = TELEPOHNE MANHOLE

* = MANHOLES INSPECTED

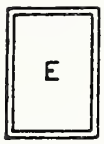
MANHOLE NUMBERS SHOWN IN CIRCLES

NOTE – MANHOLE 80 WAS INSPECTED BUT NOT SHOWN ON THE PLAN

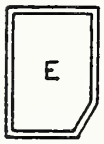
NORTH

SCALE: 1" = 500'

FIGURE 77

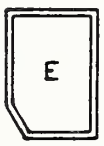


– 17, 18, 22, 23, 24, 27, 28, 46, 58, 59, 69, 78, 85

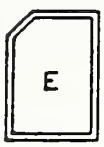


– 1

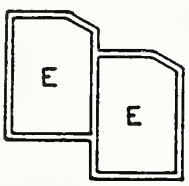
– 2, 3



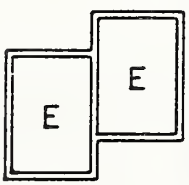
– 4



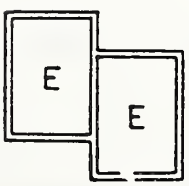
– 6



– 5



– 11



– 9, 12

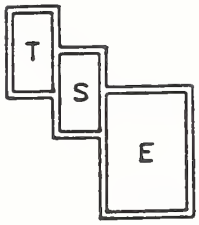
Manhole Configurations and Numbering

E = electric manhole

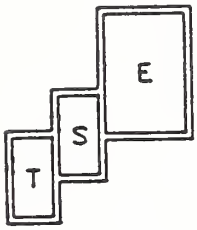
S = signal manhole

T = telephone manhole

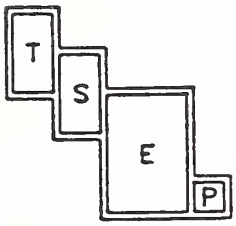
FIGURE 78



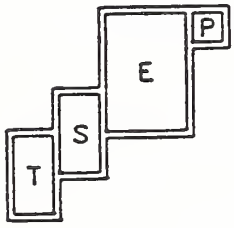
– 15, 21, 25, 29,
30, 33, 35, 36, 37,
40, 43, 45, 47,
60, 61. 62, 63, 64, 65,
72



– 13, 26,
31, 32, 34, 38,
42, 44, 48, 49, 62A



– 50, 52, 74



– 53

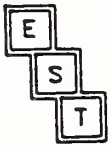
Manhole Configurations and Numbering

E = electric manhole

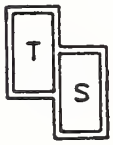
S = signal manhole

T = telephone manhole

– 14, 19, 39, 73

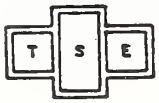


– 56, 57, 83, 84

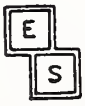


– 16, 20, 41, 51

– 7, 8, 10



– 67



– 55

– 54, 68

– 66

FIGURE 79

Figures 80 to 99: Examples of Distress in Electric, Signal, and Telephone Manholes.

ELECTRIC MANHOLE 5B: RUST STAINS ON CEILING

TELEPHONE MANHOLE 13: CRACK AT BOTTOM OF ACCESS HOLE

FIGURE 80

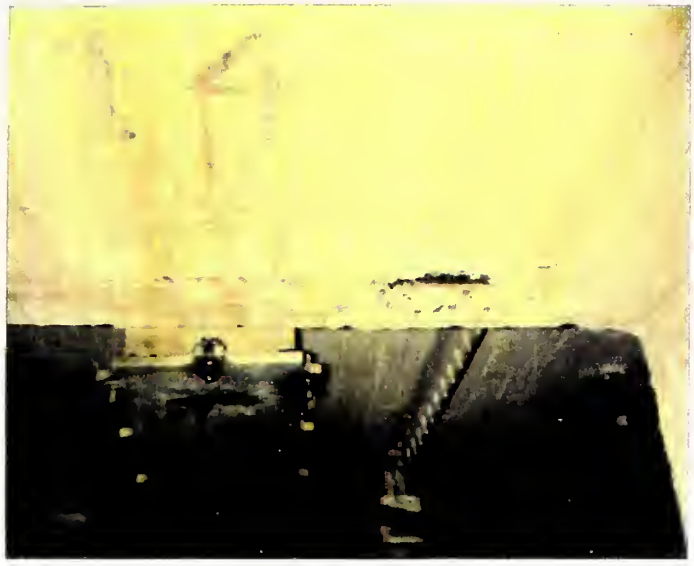
ELECTRIC MANHOLE 13: NORTHWEST WALL, SEVERE DELAMINATION

ELECTRIC MANHOLE 13: WEST WALL, SEVERE RUST STAINS

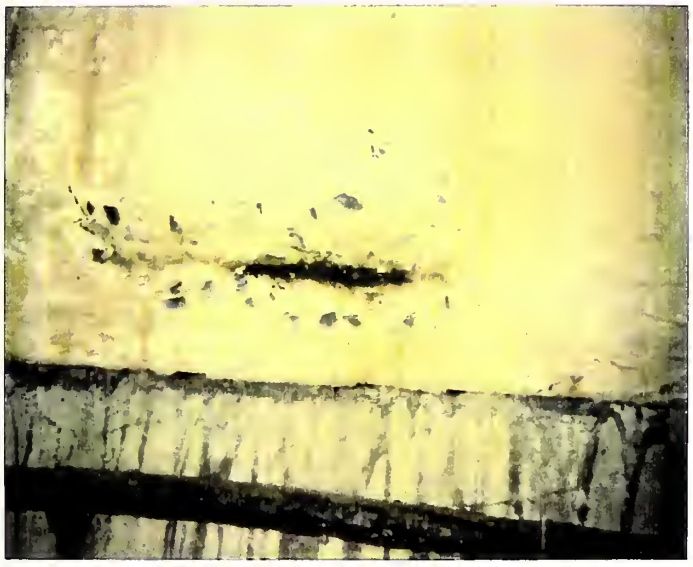
FIGURE 81

SIGNAL MANHOLE 13: WEST WALL, SEVERE DELAMINATION

FIGURE 82



SIGNAL MANHOLE 14: ACCESS HOLE, CRACKING, SPALLING, AND DELAMINATION



SIGNAL MANHOLE 14: ACCESS HOLE, CRACKING AND EXPOSED CORRODED REINFORCEMENT

FIGURE 83

ELECTRIC MANHOLE 21: DELAMINATION AT CORNER

FIGURE 84

SIGNAL MANHOLE 29: ACCESS HOLE, SEVERE CRACKING AND DELAMINATION

SIGNAL MANHOLE 38: EXPOSED REBAR/DELAMINATION AT ACCESS HOLE

FIGURE 85

ELECTRIC MANHOLE 44: CEILING DELAMINATION/ RUST STAINS

ELECTRIC MANHOLE 44: CEILING DELAMINATION/ RUST STAINS

FIGURE 86

ELECTRIC MANHOLE 50: CEILING, EXPOSED REBAR/DELAMINATION AT BOTTOM OF ACCESS HOLE

ELECTRIC MANHOLE 50: CEILING, EXPOSED REBAR/DELAMINATION AT BOTTOM OF ACCESS HOLE

FIGURE 87

ELECTRIC MANHOLE 50: CEILING, EXPOSED REBAR/DELAMINATION AT BOTTOM OF ACCESS HOLE

ELECTRIC MANHOLE 50: CEILING DELAMINATION

FIGURE 88

ELECTRIC MANHOLE 50: DELAMINATION ON SOUTH WALL

SIGNAL MANHOLE 50: CEILING, EXPOSED REBAR/DELAMINATION AT BOTTOM OF ACCESS HOLE

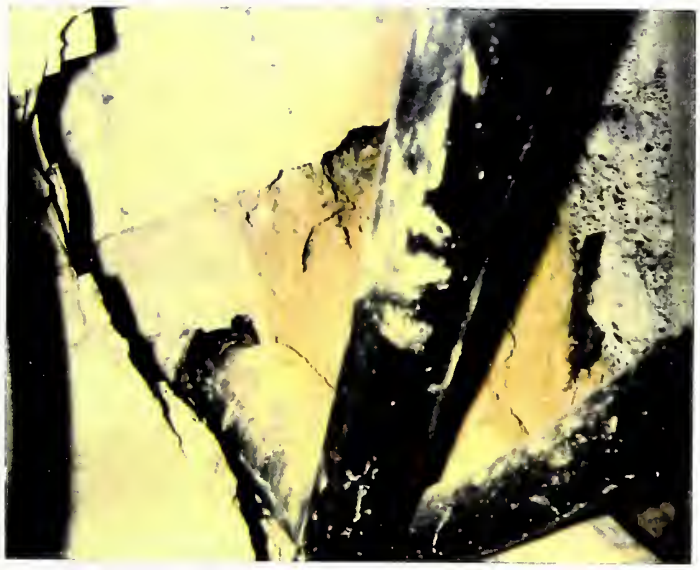
FIGURE 89

SIGNAL MANHOLE 50: DELAMINATION ON BLOCKOUT AT SOUTHEAST CORNER

SIGNAL MANHOLE 50: EXPOSED REBAR AND DELAMINATION ON CEILING, SOUTHEAST CORNER

FIGURE 90

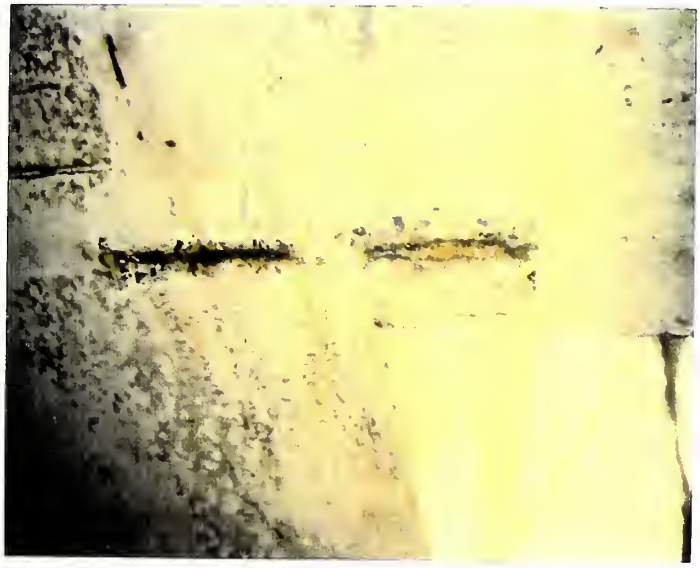
TELEPHONE MANHOLE 50: COLLAPSED BLOCKOUT ON NORTH WALL



TELEPHONE MANHOLE 50: COLLAPSED BLOCKOUT ON NORTH WALL

FIGURE 91

TELEPHONE MANHOLE 53: DELAMINATION ON NORTH WALL



ELECTRIC MANHOLE 64: EXPOSED REBAR ON CEILING NEAR ACCESS HOLE

FIGURE 92

SIGNAL MANHOLE 64: DELAMINATION IN NORTH WALL (UPPER)

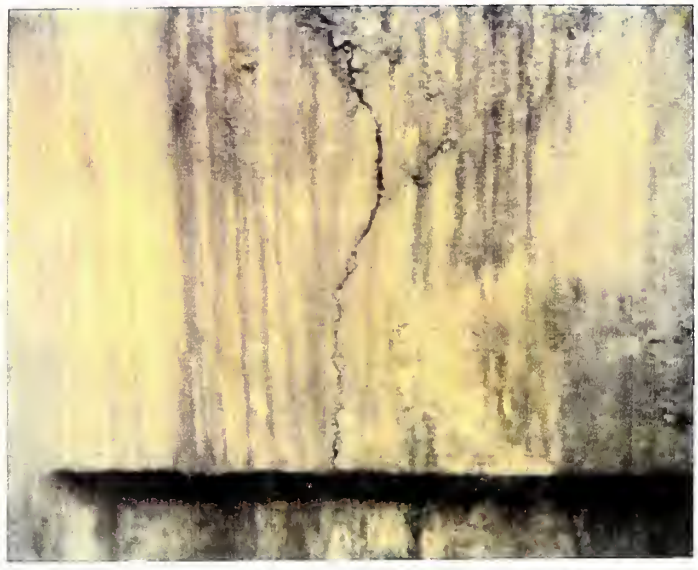
SIGNAL MANHOLE 64: DELAMINATION IN NORTH WALL (LOWER)

FIGURE 93

TELEPHONE MANHOLE 67: CRACK IN NORTH WALL (UPPER)

TELEPHONE MANHOLE 67: CRACK IN NORTH WALL (LOWER)

FIGURE 94



TELEPHONE MANHOLE 67: CRACK IN SOUTH WALL (UPPER)

TELEPHONE MANHOLE 67: CRACK IN SOUTH WALL (LOWER)

FIGURE 95

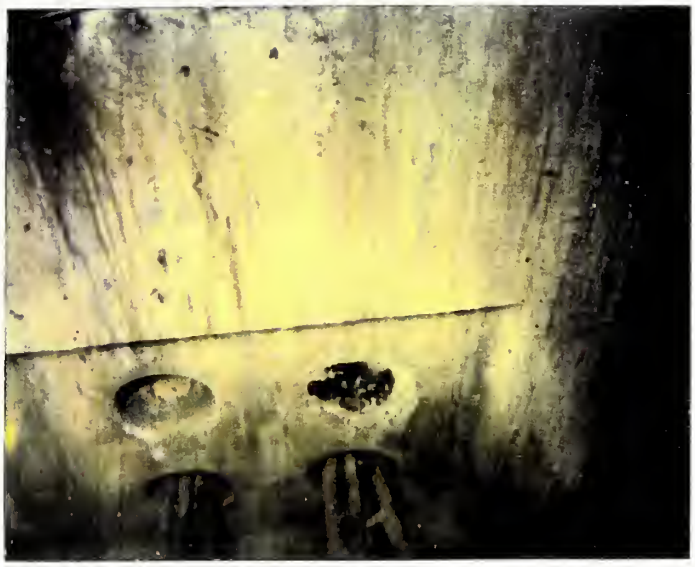
SIGNAL MANHOLE 67: CRACKS IN SOUTH WALL (UPPER) - INK USED ON PHOTO TO ENHANCE CRACKS

FIGURE 96

SIGNAL MANHOLE 67: CRACKS IN NORTH WALL (UPPER)- INK USED ON PHOTO TO ENHANCE CRACKS

SIGNAL MANHOLE 67: CRACKS IN NORTH WALL (LOWER)- INK USED ON PHOTO TO ENHANCE CRACKS

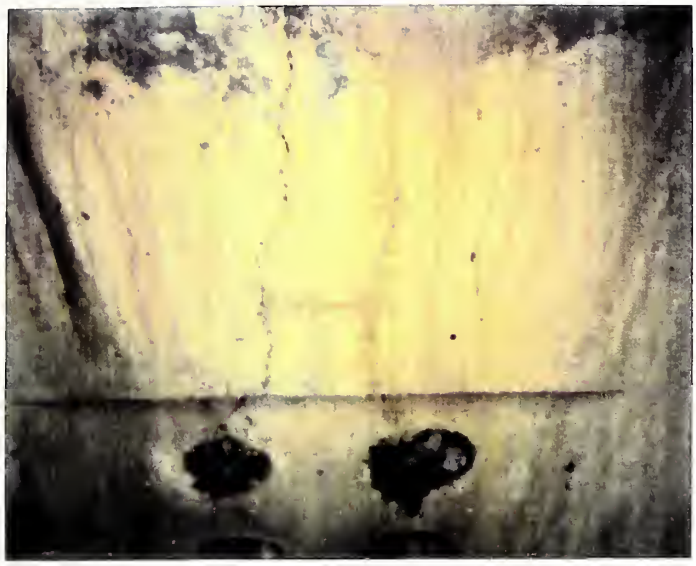
FIGURE 97



ELECTRIC MANHOLE 67: CRACKING IN NORTH WALL (UPPER)

ELECTRIC MANHOLE 67: CRACKING IN NORTH WALL (LOWER)

FIGURE 98



ELECTRIC MANHOLE 67: CRACKING IN SOUTH WALL (UPPER)

ELECTRIC MANHOLE 67: CRACKING IN SOUTH WALL

FIGURE 99

APPENDIX A

A1: IDENTIFICATION OF HAZARDS OF FALLING CONCRETE FROM DELAMINATED CONCRETE IN NIST FACILITIES

A2: PROPOSED APPROACH/PRIORITIES FOR REMOVAL OF DELAMINATED CONCRETE IN NIST FACILITIES

Identification of Hazards of Falling Concrete from Delaminated Concrete in NIST Facilities

Areas that have the potential for hazardous falling concrete due to delaminated reinforced concrete or delaminated fire-proofing concrete on steel shapes are listed below. Each area needs to be further evaluated to determine to what degree the concrete is adhered. Loosely adhered concrete can be identified by visual inspection and hammer sounding. If it is found that the concrete is on the verge of falling or being dislodged, it is recommended that the hazard of falling concrete be addressed as soon as possible.

Based on the delaminations found in recent surveys of the underground reinforced concrete structures, including the steam, electric, signal, and telephone manholes, it is recommended that necessary precautions be taken relative to the hazard of falling debris in all NIST underground reinforced concrete structures, as well as in the above ground structures referenced below.

The areas listed below are by building number, not priority. Priority of the areas is addressed in A2, Appendix A.

A number of the areas listed below have had their delaminated concrete removed. Three of these areas are discussed below. All the areas which have had their delaminated concrete removed are given in Table 1. Information in this Appendix is to be used with Table 1.

1. Bldg. 101, underneath overhang on south wall of library, several spots, about 2.6 m (8.5 ft) above the ground.

2. Bldg. 101, fresh air pits on south side of library, delaminations on walls (2.1 m (7 ft) maximum above the floor) and on all four faces (2.1 m (7 ft) maximum above the floor) of three beams .

3. Bldg. 101, exterior columns just south of Health Unit entrance, need to be evaluated, some areas about 3.1 to 3.4 m (10 to 11 ft) above the ground.

4. Bldg. 206, storage bins, lower (floor) level. Delaminations verified by sounding, maximum height is about 2.4 to 3.1 m (8 to 10 ft) above floor.

5. Bldg. 206, upper level sand/stone storage bin, second bin from west end, access from roof area. Delaminations are very severe on walls and ceiling and no one should be allowed in this bin. The westernmost bin and the third bin from the west end also have delaminations on the underside of metal vents which are located on the ceiling in the center of each bin. As a precautionary measure,

be sure that the hole in the floor of each of the three bins is closed, preventing the possibility of someone tripping or falling through to the floor below.

6. Bldg. 220, Rm. C09, Transformer Room, need to verify if delaminated concrete is present on beam-column connection 3.1 m (10 ft) off the ground.

7. Bldg. 220, fresh air intake pit on E side of Bldg. 220, access from Mechanical Room, C08. About 0.05 sq m (1/2 sf) delamination on S wall of pit about 3.4 m (11 ft) off floor.

8. Bldg. 222, Telephone Closet, Rm. A 01, northernmost portion, visible delaminations present, verified by hammer sounding, 3.4 to 4.0 m (11 to 13 ft) above the floor.

9. Bldg. 226, Rm. B03, northernmost portion, visual delaminations (some delaminations verified by hammer sounding), 3.7 m (12 ft) off floor.

10. Bldg. 230, fresh air intake pit at northwest corner of Bldg. 230, accessible from Rm. C 04, Bldg. 230. Several areas of severe delamination ranging from the floor level to almost at the top of the pit, about 5.5 m (18 ft) off the floor, are visible. The delaminated areas are fairly large in size, ranging from about 0.3 to 0.6 m (1 to 2 ft) or more in each dimension. Also worth noting is severe corrosion of the door frame leading out to the pit from Room C 04, in Bldg. 230. On April 24, 1991, a temporary sign was put on the access door to the pit. Based on a concern that signs may not be effective, it is recommended that the appropriate Plant personnel be notified and periodically reminded of this hazard so that the area can be closed off to everyone until the hazards are eliminated. Most delaminated concrete was removed in 1991; an additional area needs to be checked: see P289, Table 1.

11. Bldg. 230, southernmost pit adjoining northwest pit at Bldg. 230, 1.2 to 1.8 m (4 to 6 ft) delaminations above the floor.

12. Bldg. 231, by the Mechanical Room, on the west side of the building, under ground (need to go down outside stairs) there is a delamination approximately 0.2 by 0.3 m (o.5 by 1.0 ft), which is 4.3 m (14 ft) off the floor in an overhead position. Plant should take the necessary precautions, until the material is removed.

13. Bldg. 231, under the shored area. Although the delaminated concrete in this area had supposedly been removed, it was reinspected in response to a verbal report that the initial concrete removal was inadequate. The area was reinspected on August 20, 1991. Because the ongoing corrosion and mechanical vibration will accelerate the formation of delaminated concrete, this area should be periodically inspected for falling concrete hazards. (Reference corresponding memorandums dated August 20 and

30, 1991 from McMullan and Associates).

14. Bldg. 231, the areas (Rm. A169 Sump and Rm. A 169) in addition to the shored areas inspected in March 1991 (reference March 15, 1991 Memorandum) should be reinspected for the hazard of falling concrete. There were at least several areas of what appeared to be badly cracked concrete, on both the reinforced concrete and the fireproofing concrete, which could pose a falling-concrete hazard.

15. Bldg. 233, Rm. A 121, delamination in reinforced concrete roof slab due to apparent water leakage, 11 to 12 m (36 to 40 ft) above the floor. The loose concrete was removed on May 13, 1991. It is recommended that this area be inspected periodically to determine if further concrete delamination has occurred.

16. Bldg. 235, Rm. D01, Pump Room, delamination on ceiling, 3.7 m (12 ft) above the floor.

17. Bldg. 235, Rm. C006, on N wall; wall appears to be bulged out, possibly delaminated; could not get close enough to confirm due to radioactivity. This is a radioactive "hot" spot and should be inspected when safe to do so.

18. Bldg. 236, north exterior wall, delaminated concrete on parapet walls and there is evidence that portions have been falling off. The parapet walls are 4.6 to 4.9 m (15 to 16 ft) off the ground.

19. Bldg. 245, Rm. A 008, a number of severely delaminated areas, which sounded hollow when struck with a hammer, about 3.4 to 4.0 m (11 to 13 ft) above the floor.

20. Bldg. 245, southeast loading dock, Rm. A120, crushed concrete at beam-column connection, about 4.6 m (15 ft) above the floor. The loose concrete was removed in 1991. It is recommended that this area be inspected periodically to determine if further concrete delamination has occurred. The concrete covering is apparently acting as fireproofing over steel shapes (need to verify presence of steel shapes). There is a white powdery material near or at the beam-column connection. Sampling and re-sampling of this material showed no asbestos using polarized light/dispersion staining microscopy.

21. Bldg. 245, construction joint, 3.1 m (10 ft) south of Rm B041 on bottom of northernmost beam, substantial distress, needs to be checked to see if delaminations are there.

22. Bldg. 245, Rm. A100, Rm. A100, Central region (with respect to east-west), on slab bottom, "visually deteriorated"; need to check if delamination and falling concrete hazards exist.

23. Bldg. 245, Rm. A007, on North Wall. Check for delaminated concrete 2.1 m (7 ft) above the floor.

24. Nike Site, Pit #3, 2.4 by 3.7 m (8 by 12 ft) bay ceiling on lower area. Need to check for delamination and falling concrete. NIST needs to decide if this area will be used; if it is to be used, then it needs to be checked and, if necessary, repaired.

25. Steam manholes and under Red Auditorium (e.g., McMullen's report of Jan. 30, 1991 on manhole delaminations on walls and ceilings and K. Clear's Oct. 1990 report on Red Auditorium's delaminations)

26. Electric, signal, and telephone manholes (e.g., see Table 2).

27. It is noted that the reports which describe delaminations in the manholes treat only a fraction of the manholes on campus; most likely there are also substantial delaminations in manholes not surveyed.

Proposed Approach/Priorities for Removal of Delaminated Concrete in NIST Facilities

Areas that have the potential for hazardous falling concrete due to delaminated reinforced concrete or delaminated fire-proofing concrete on steel shapes are identified in A1, Appendix A (which is being continually updated). Each area identified in A1 needs to be further evaluated to determine to what degree the delaminated concrete is adhered. Loosely adhered concrete can be identified by visual inspection and hammer sounding. If it is found that the delaminated concrete is on the verge of falling or being dislodged, it is recommended that the hazard of falling concrete be addressed as soon as possible.

A number of the areas listed below have had their delaminated concrete removed. Three of these areas are discussed below. All the areas which have had their delaminated concrete removed are given in Table 1. Information in this Appendix is to be used with Table 1.

For structural safety reasons, the cases of delaminated concrete have been divided into three categories. In Category I, there is the liklihood that removal of the concrete would substantially weaken the structure. For these cases, it is recommended that a structural engineer assess each site prior to removal of the concrete to determine if removal of the concrete will result in a substantial decrease in structural safety. Those cases in which it is determined that the concrete could be removed without a substantial decrease in structural safety, would be put into Category II. In the Category II cases, the structural engineer should accompany the plant personnel when the concrete is removed to: (a) provide guidance as to the quantity of concrete that could be removed without causing structural distress, (b) assess the structural state and determine if any substantial structural distress has occurred, and (c) to estimate the necessity, if any, of structural repairs. Those cases in which a more detailed structural assessment is needed prior to removing the concrete, would be put into Category III.

Note: In what follows, numbers used refer to the priority - P1 has the highest priority, P2 the next highest priority, etc. Also, "a" and "b" denote equal priority.

The areas listed below do not include the steam, electric, signal, and telephone manholes. These manholes need to be addressed.

Category I

P-1. Bldg. 233, Rm. A 121, delamination in reinforced concrete roof slab due to apparent water leakage, 11 to 12 m (36 to 40 ft) above the floor. The loose concrete was removed on May 13, 1991. It is recommended that this area be inspected periodically to determine if further concrete delamination has occurred. This area needs immediate attention with regard to an analysis for structural safety.

P-2. Bldg. 245, southeast loading dock, Rm. A120, crushed concrete at beam-column connection, about 4.6 m (15 ft) above the floor. The delaminated concrete was removed in 1991. It is recommended that this area be inspected periodically to determine if further concrete delamination has occurred. The concrete covering is apparently acting as fireproofing over steel shapes (need to verify presence of steel shapes). This area needs immediate attention with regard to an analysis for structural safety.

There is a white powdery material near or at the beam-column connection. Sampling and re-sampling of this material showed no asbestos using polarized light/dispersion staining microscopy.

P-3. Bldg. 231, the deteriorated areas, Rm. A169 Sump and Rm. A 169, in addition to the shored areas inspected in March 1991 (reference March 15, 1991 Memorandum) should be reinspected for the hazard of falling concrete. There were at least several areas of what appeared to be badly cracked concrete, on both the reinforced concrete and the fireproofing concrete, which could pose a falling-concrete hazard.

P-4. Bldg. 230, fresh air intake pit at northwest corner of Bldg. 230, accessible from Rm. C 04, Bldg. 230. Several areas of severe delamination ranging from the floor level to almost at the top of the pit, about 5.5 m (18 ft) off the floor are visible. The delaminated areas are fairly large in size, ranging from about 0.31 to 0.61 m (1 to 2 ft) or more in each dimension. Also worth noting is severe corrosion of the door frame leading out to the pit from Room C 04, in Bldg. 230. On April 24, 1991, a temporary sign was put on the access door to the pit. Based on a concern that signs may not be effective, it was recommended that the appropriate Plant personnel be notified and periodically reminded of this hazard so that the area can be closed off to everyone until the hazards are eliminated. Most delaminated concrete was removed in 1991; an additional area needs to be checked: see P289, Table 1.

P-5a. Bldg. 206, upper level sand/stone storage bin, second bin from west end, access from roof area. Delaminations are very severe on walls and ceiling and no one should be allowed in this bin. The westernmost bin and the third bin from the west end also have delaminations on the underside of metal vents which are

located on the ceiling in the center of each bin. As a precautionary measure, be sure that the hole in the floor of each of the three bins is closed, preventing the possibility of someone tripping or falling through to the floor below.

P-5b. Bldg. 206, storage bins, lower (floor) level. Delaminations verified by sounding, maximum height is about 2.4 to 3.1 m (8 to 10 ft) above floor.

P-6. Bldg. 235, Rm. C006, on N wall; wall appears to be bulged out, possibly delaminated; could not get close enough to confirm due to radioactivity. This is a radioactive "hot" spot and should be inspected when safe to do so.

P-7a. Bldg. 222, Telephone Closet, Rm. A 01, northernmost portion, visible delaminations present, verified by hammer sounding, 3.4 to 4.0 m (11 to 13 ft) above the floor.

P-7b. Bldg. 226, Rm. B03, northernmost portion, visual delaminations (some delaminations verified by hammer sounding), 3.7 m (12 ft) off floor.

P-8. Bldg. 231, under the shored area. Although the delaminated concrete in this area had supposedly been removed, it was reinspected in response to a verbal report that the initial concrete removal was inadequate. The area was reinspected on August 20, 1991. Because the ongoing corrosion and mechanical vibration will accelerate the formation of delaminated concrete, this area should be periodically inspected for falling concrete hazards. (Reference corresponding memorandums dated August 20 and 30, 1991 from McMullan and Associates).

P-9. Bldg. 235, Rm. D01, Pump Room, delamination on ceiling, 3.7 m (12 ft) above the floor.

P-10. Bldg. 231, by the Mechanical Room, on the west side of the building, under ground (need to go down outside stairs) there is a delamination approximately 0.15 by .31 m (0.5 by 1 ft), which is 4.3 m (14 ft) off the floor in an overhead position. Plant should take the necessary precautions, until the material is removed.

P-11. Bldg. 245, construction joint, 3.1 m (10 ft) south of Rm B041 on bottom of northernmost beam, substantial distress, needs to be checked to see if delaminations are there.

P-12. Bldg. 245, Rm. A 008, a number of severely delaminated areas, which sounded hollow when struck with a hammer, about 3.4 to 4.0 m (11 to 13 ft) above the floor.

P-13. Bldg. 220, Rm. C09, Transformer Room, need to verify if

delaminated concrete is present on beam-column connection 3.1 m (10 ft) off the ground.

P-14. Bldg. 236, north exterior wall, delaminated concrete on parapet walls and there is evidence that portions have been falling off. The parapet walls are 4.6 to 4.9 m (15 to 16 ft) off the ground.

P-15. Bldg. 101, exterior columns just south of Health Unit entrance, need to be evaluated, some areas about 3.1 to 3.4 m (10 to 11 ft) above the ground.

P-16. Nike Site, Pit #3, 2.4 by 3.7 m (8 by 12 ft) bay ceiling on lower area. Need to check for delamination and falling concrete. NIST needs to decide if this area will be used; if it is to be used, then it needs to be checked and, if necessary, repaired.

P-17. Bldg. 230, southernmost pit adjoining northwest pit at Bldg. 230, 1.2 to 1.8 m (4 to 6 ft) delaminations above the floor.

P-18. Bldg. 101, underneath overhang on south wall of library, several spots, about 2.6 m (8.5 ft) above the ground.

P-19. Bldg. 101, fresh air pits on south side of library, delaminations on walls (2.1 m (7 ft) maximum above the floor) and on all four faces (2.1 m (7 ft) maximum above the floor) of three beams .

P-20. Bldg. 220, fresh air intake pit on E side of Bldg. 220, access from Mechanical Room, C08. About 0.05 sq m (1/2 sf) delamination on S wall of pit about 3.4 m (11 ft) off floor.

P-21. Bldg. 245, Rm. A007, on North Wall. Check for delaminated concrete 2.1 m (7 ft) above the floor.

P-22. Bldg. 245, Rm. A100, Rm. A100, Central region (with respect to east-west), on slab bottom, "visually deteriorated"; need to verify if delamination and falling concrete hazards exist. (NIST needs to evaluate prior to structural engineer evaluation)

Category II (Include those cases from Category I in which it is determined that the delaminated concrete can be removed without a substantial decrease in structural safety; a structural engineer should accompany the plant personnel when the concrete is removed.)

Category III (Include those cases from Category I where a more detailed structural assessment is needed prior to removing the delaminated concrete.)

It is advisable to collect and review the plans and dimensions of all the above areas prior to the areas being assessed.

Note: Categories similar to those used for buildings could also be used to evaluate the hazard of falling concrete in the steam, electric, signal, and telephone manholes.

NIST-114A
(REV. 3-90)

U.S. DEPARTMENT OF COMMERCE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

BIBLIOGRAPHIC DATA SHEET

1. PUBLICATION OR REPORT NUMBER
NISTIR 4868

2. PERFORMING ORGANIZATION REPORT NUMBER

3. PUBLICATION DATE
AUGUST 1992

4. TITLE AND SUBTITLE

Interim Report: Preliminary Sitewide Survey of Reinforced Concrete Structural Deterioration at the National Institute of Standards and Technology (NIST)

5. AUTHOR(S)

Lawrence I. Knab

6. PERFORMING ORGANIZATION (IF JOINT OR OTHER THAN NIST, SEE INSTRUCTIONS)

U.S. DEPARTMENT OF COMMERCE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
GAITHERSBURG, MD 20899

7. CONTRACT/GRANT NUMBER

8. TYPE OF REPORT AND PERIOD COVERED

9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS (STREET, CITY, STATE, ZIP)

10. SUPPLEMENTARY NOTES

11. ABSTRACT (A 200-WORD OR LESS FACTUAL SUMMARY OF MOST SIGNIFICANT INFORMATION. IF DOCUMENT INCLUDES A SIGNIFICANT BIBLIOGRAPHY OR LITERATURE SURVEY, MENTION IT HERE.)

A sitewide investigation of the condition of the reinforced concrete is being carried out at the NIST facilities in Gaithersburg, MD. In the first phase, a visual survey was conducted primarily in the interior of buildings and their adjacent structures. Additionally, over 40 percent (78 out of 175) of the electric, signal, and telephone manholes were visually surveyed and their walls and ceilings were sounded for delamination. This interim report presents the observed distress, presents a priority list for repairing the deteriorated concrete areas, identifies needed tests, and shows the anticipated locations and costs of test samples.

12. KEY WORDS (6 TO 12 ENTRIES; ALPHABETICAL ORDER; CAPITALIZE ONLY PROPER NAMES; AND SEPARATE KEY WORDS BY SEMICOLONS)

carbonation; chloride ion; concrete; condition; corrosion; cost; deterioration; repair; reinforcement; testing

13. AVAILABILITY

- [ ] UNLIMITED
- [X] FOR OFFICIAL DISTRIBUTION. DO NOT RELEASE TO NATIONAL TECHNICAL INFORMATION SERVICE (NTIS).
- [ ] ORDER FROM SUPERINTENDENT OF DOCUMENTS, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, DC 20402.
- [ ] ORDER FROM NATIONAL TECHNICAL INFORMATION SERVICE (NTIS), SPRINGFIELD, VA 22161.

14. NUMBER OF PRINTED PAGES

15. PRICE

ELECTRONIC FORM